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Environmental Assessment

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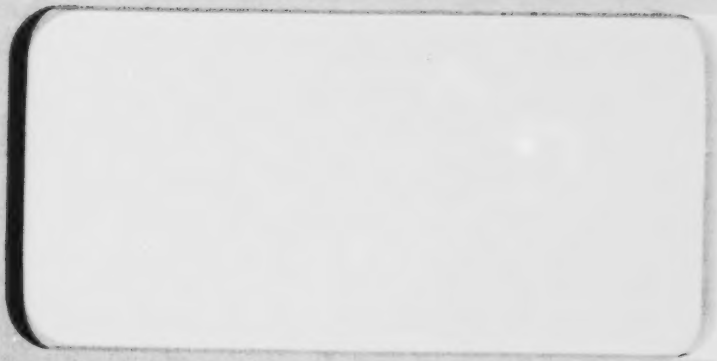

MARKET ASSESSMENT PROGRAM
ESTIMATING WASTE QUANTITIES

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ONTARIO RESEARCH FOUNDATION

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September, 1986

Final Report on Project P-4578/G

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November, 1986

N O T E

The report "Estimating Waste Quantities" was prepared in 1984 by the Ontario Research Foundation. The report has been printed because it represents an attempt to describe and document the various studies that have been conducted that estimate quantities of "special waste" in Ontario. Reports that deal with waste quantity estimation can have significant problems based on the report purpose, the definition used for measurement and the methodology used for determining quantities. The report illustrates these problems in a logical, consistent analysis.

Work on this report was concurrent with other Market Assessment work and frequently dealt with draft information or commented on the work in studies that had not been completed. This is especially relevant to the Canviro Survey of 500 Companies which we asked ORF to evaluate as part of this process. A further 500 companies were added to the study and more extensive efforts were made to analyze the data subsequent to this report.

Measurement and prediction of special waste quantities is a complex task and one that may never be done with precision. This report may serve to illustrate the complexity of the measurement of special waste, but more importantly, may give some further understanding of the measurement issues to the reader.

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October 10, 1986.

LETTER OF TRANSMITTAL

Mr. W. R. Lightowlers,
Director, Marketing and Sales,
Ontario Waste Management Corporation,
2 Bloor Street West,
11th Floor,
Toronto, Ontario
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Dear Mr. Lightowlers:

We are pleased to submit this final report on our study to develop an approach to waste quantity estimating. This work was completed in January, 1985, and a final working draft submitted at that time. This final version incorporates some minor format and style changes, but includes only information developed during the study period.

We are grateful to have had the opportunity to serve OWMC in conducting this most interesting and challenging project.

Yours very truly,

R. G. W. Laughlin
Assistant Director
Environmental & Chemical
Engineering Division

RGWL/id
enc.

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Estimating Waste Quantities

for

Ontario Waste Management Corporation

EXECUTIVE SUMMARY

PURPOSE OF THE REPORT

This study is one of a series being undertaken to assist in the development of a proposal for the capacity of the waste management facilities to be built by the Ontario Waste Management Corporation.

This study addresses the problems involved in estimating the quantities of special wastes in Ontario and examines the factors which will influence those quantities in the future, and proposes a method that seems best able to achieve reliable estimates of waste quantities generated and OWMC's potential market share.

SCOPE AND METHOD

This study consisted essentially of three parts:

- Comparison of previous waste estimates
- Review of factors affecting waste quantities
- Development of a proposed approach to future waste quantity estimates

(a) Comparison of Previous Waste Estimates

Previous studies which addressed waste quantity estimates for Ontario were selected for review. In addition, important non-Ontario waste quantity estimates utilized by those studies were included. A total of sixteen previous waste quantity studies were critically reviewed and their methodologies were analyzed.

The 16 studies were grouped according to the approach which they took to estimating waste quantities. Three major methodologies were identified, the third having three subgroups:

- Waste Transfer Permit Data
- Inventory of Targeted Industries
- Waste Generation Survey Estimate
  - Data from the study area only
  - Data from the study area plus other survey data
  - Other survey data only

Five studies were chosen, one from each of the groups, for a critical comparison of each of these approaches to Waste Quantity Estimating. The five studies were chosen on the basis of their having the most direct relevance to Ontario and to OWMC. The five studies chosen were:

(1) Ministry of the Environment Waybill
(2) CCPA Survey of Chemical Manufacturers
(3) Canviro: Survey of 500 Industrial Establishments
(4) OWMC Waste Quantities Study
(5) Gore and Storrie: National Inventory of Hazardous Waste

The approaches taken were critically compared in CHAPTER 2 in terms of what waste quantities each was estimating; how data were extrapolated, and how comparable were the projected numbers.

(b) Review of Factors Affecting Waste Quantities

The factors influencing industrial waste generation rates and influencing the fate of industrial wastes were considered and discussed. Of particular concern is the effect of these parameters on future trends in waste quantities. Four types of waste quantity estimates were identified:

- Total industrial waste generated
- Total special wastes generated
- Special wastes requiring off-site treatment
- OWMC market share

The factors affecting each of these waste quantities were identified, as were factors influencing the relationship between types of waste quantity estimates.

(c) Development of a Proposed Approach to Future Waste Quantity Estimates

An approach to future waste quantity estimates was developed. This approach was designed to build on the current data available, to refine it and augment it with additional targeted data to increase the proportion of the waste quantity estimate which has actually been inventoried.

PREMISES AND POSTULATES

None were identified.

STATUS OF DATA

The level of detail on methodology, approach and the data generated was not uniform for all 16 reports. The project team had some difficulty in verifying the methods and data bases used by some of the studies. It is not expected that this affected the conclusions of the study. At the time of completing the study, only a draft copy of the Canviro report, Survey of 500 Industrial Establishments, was available. These data are now incorporated into the published report, Survey of 1000 Industrial Establishments [Canviro, 1985].

MAJOR FINDINGS

COMPARISON OF PREVIOUS WASTE ESTIMATES

The aggregated totals of the three most complete estimates of waste quantities generated in Ontario are very consistent. However, there are large differences in estimates for individual industry categories which cast doubt on the consistent aggregated totals. It suggests that their similarity may be coincidental. The three studies used two different approaches. The inconsistencies between these studies cannot be attributed solely to the approach since the consistency is no better between the two studies using the same approach than it is between either of these and the third. Other factors were concluded to be influencing the inconsistent results of these studies. These are:

- Lack of a clear definition of special wastes.
- Lack of suitability of SIC as a grouping for industrial waste generation estimates.

- Poor business statistics available for the extrapolation of waste quantities to an all-Ontario estimate compound the difficulty with SIC noted above.

FACTORS AFFECTING WASTE QUANTITIES

There are four major waste quantity estimates which can be made:

- Total Industrial Waste Generated
- Total Special Wastes Generated
- Special Wastes Requiring Off-site Treatment and Disposal
- Market Share for an Individual Waste Management Company

There are a number of factors which influence the quantities of waste produced by industry and the relationships between the four waste quantity estimates. These are summarized in Figure 3.4 (p 54).

The estimate which is most readily made with the fewest anomalies is for Special Wastes Requiring Off-site Treatment and Disposal.

With a good definition of "Special Waste", reliable estimates of Total Industrial Special Waste Generated should be feasible.

Reliable estimates of Total Industrial Waste Generated are always going to be difficult because of inconsistencies in what is incorporated into total quantity estimate. Market Share Estimates are also difficult because they are specific and dependent upon market forces and actions of the individual waste management companies.

PROPOSED APPROACH TO FUTURE WASTE QUANTITY ESTIMATES

Information from other jurisdictions suggests that, for Ontario, 500-1000 companies will probably be responsible for generating 90% of the volume of special wastes. Thus, a targeted survey of 1000-1500 Ontario companies could actually inventory 90% of the waste and still give enough information on smaller generators to extrapolate the minor quantities of wastes.

Our proposed approach to refining current waste quantity estimates is a targeted inventory of major waste generators (See Figure 4.1, p 72). It has the following characteristics:

- It relies heavily on using the raw data from the surveys by Canviro Consultants of Industrial Establishments [Canviro, 1985].
- It could incorporate survey data developed in two previous studies undertaken for OWMC to expand the data base.
- It relies on the survey method rather than on waste generation factors.
- However, it indirectly utilizes waste generation factors to target the survey to try to inventory, through actual interview rather than extrapolation, all major waste generators.

CONCLUSIONS AND RECOMMENDATIONS

The following conclusions were drawn from the study:

- That a targeted survey approach to waste quantity estimating is likely to yield the most accurate and useful data
- That a clear definition of special waste is critical to the consistency of the results of such a survey
- That this definition would be most effective if based on a legislatively defined degree of hazard.
- That a process-oriented grouping method would enhance Standard Industrial Classification for assessing and extrapolating waste quantity estimates
- That improved business statistics would improve the extrapolation of waste quantity estimates.

Two Recommendations are made based on this study:

1. That OWMC work with the Ontario Ministry of the Environment to develop a definition of special waste based on legislatively defined degree of hazardousness.

2. That OWMC follow the approach proposed in this report to refine and update their special waste quantity estimates for Ontario.

CHAPTER 1
INTRODUCTION AND BACKGROUND

OWMC has, as its mandate, the implementation of a province-wide program for the management of liquid industrial and hazardous waste. OWMC has defined liquid industrial waste and hazardous waste or special waste as "waste that requires special treatment", that is, waste that cannot be adequately dealt with by the conventional methods used by existing public facilities, i.e. municipal sewage treatment plants, municipal incinerators and municipal landfills.

Obviously a key requirement for OWMC is a comprehensive understanding of the quantities and types of wastes generated in the Province of Ontario. Further, the fate of those wastes must be understood along with parameters affecting the future quantities of wastes generated and requiring special treatment and disposal facilities.

Several studies have been undertaken directly for OWMC [OWMC Waste Quantities Study, 1982], [Canviro Consultants, 1985], or for others [Gore and Storrie, 1982], [MOE Waybill, 1984], etc., estimating waste quantities generated in the Province of Ontario. The reports of these studies have shown some wide discrepancies in the quantity estimate they have developed. These discrepancies may be the result of either:

- Bad estimating
- Not estimating the same thing, e.g. one report estimating waste quantities generated being compared to another estimating wastes requiring off-site treatment.

- Changes in waste quantities over time due to waste reduction or general economic conditions.

The objectives of this current study are:

(a) to critically review the studies which have been conducted on waste quantities in Ontario plus several reports used by these studies to generate waste emission factors;

(b) to compare the methodologies utilized and what these studies were actually estimating, and thereby to try to rationalize these disparate estimates;

(c) to recommend an approach to waste quantities estimating to OWMC, which will:
    - estimate total special waste generated in the province
    - break down the total waste generated estimates
        - by category (chosen to reflect treatment requirements)
        - by geographic region
        - by industrial generator and size of generation
        - by current fate, e.g. on-site treatment, off-site recycling, off-site treatment and disposal, etc.
    - be readily updatable over time as economics and processes change and waste reduction measures are implemented.
    - Utilize as much currently available survey data as possible, to minimize the costs of refining current estimates.

CHAPTER 2
REVIEW AND COMPARISON OF METHODOLOGIES

2.1 OVERVIEW OF THE DETAILED REVIEW OF REPORTS (APPENDIX D)

Sixteen reports are reviewed in Appendix D of this report, all of which have either estimated industrial waste quantities in Ontario or have been used as data sources by other studies which have estimated quantities for Ontario. The format chosen for these reviews is to pose and answer a series of six questions and to follow that with a commentary section. The six questions which are addressed in each review are as follows:

- What is the relevance of this study to OWMC?
- What waste quantity is this study estimating?
- What waste categories does this study use?
- What method did the study use to generate waste quantity data?
- How did the study extrapolate waste quantity estimate to Ontario data?
- How useful is this report to future waste quantity estimates?

While this approach to the reviewing process has a negative effect on its literary style, it ensures that the important questions are addressed and results in consistent organization of each of the reviews. This will make it easier for the reader to make his own comparisons between the different studies. The commentary section picks up other important information from the various reports.

2.2 METHODOLOGIES TO MEASURE SPECIAL WASTES

Direct measurement of special waste generation by every industry located in a jurisdiction as large as Ontario (which has about 25,000 manufacturing firms) is not be feasible. Therefore, a technique must be employed to obtain an estimate of waste production from limited data. Methodologies to accomplish this are of three general types, viz:

(1) Waste transfer permit data
(2) Targeted waste inventory
(3) Extrapolation by generation factors

Waste transfer permits have been used in Ontario and the State of California to estimate waste generation. The permits have the primary purpose of providing regulatory agencies with a tool to ensure the safe movement and fate of special wastes.

Waste transfer permit data have been used in California to provide a basis for hazardous waste management. There the permits were collected over a two month period for all waste shipments to Class I and Class II-1 (defined in California State Regulations) secure landfills. The annual waste generation for the State was simply estimated by multiplying the reported amounts in the permits for 2 months by 6 and adding a small correction factor to account for pesticide containers not generated during the two month survey period.

In Ontario, the MOE Waybill was initiated in 1979 to monitor the transfer of liquid industrial wastes between waste generators, waste haulers, and waste disposal and/or recycling firms.

Targeted waste inventories have been conducted in New York State, in the Regional Municipality of Waterloo and in Ontario by Canadian Chemical Producers Association (CCPA). In each case, a survey was conducted of industries selected on specific bases. The New York inventory concentrated on the small percentage of industries in that State suspected of generating significant quantities of hazardous waste. The Waterloo Regional study was limited to a relatively small region. The CCPA study distributed its questionnaire to primarily chemical producing industries belonging to one (or more) of several manufacturers' associations.

The results of each of these targeted inventories were not extrapolated.

Many hazardous waste studies have employed some basis to extend the results of necessarily limited surveys to represent entire jurisdictions. The technique most often employed has been extrapolation by the number of employees and/or the number of establishments within a geographical area. Results are categorized by the primary Standard Industrial Classification (SIC) code of surveyed industries. Different levels of resolution have been employed, i.e. two, three or four digit SICs to group survey data to develop waste generation factors on the basis of the number of employees or establishments.

Surveys employing waste generation factors may be divided into three groups, depending upon the source of the generation factors. The survey of 500 Ontario establishments conducted for OWMC by Canviro Consultants Limited is one example of a survey employing only factors derived from the jurisdiction of concern. The earlier OWMC Waste Quantities survey employed

both factors obtained from a limited survey of Ontario industries and from studies conducted in other jurisdictions. The Mitre report and the Gore and Storrie report were examples of waste estimates developed which used data from other surveys exclusively.

Table 2.1 lists the various methodologies and the various waste surveys reviewed in this report as examples.

2.3 CHOICE OF STUDIES FOR COMPARISON

The studies listed in Table 2.1 were reviewed under a number of simple criteria in order to choose those studies to be reviewed in more detail and compared. An example of each of the five alternative methodologies was chosen. The selected studies presented estimations of special wastes generated in Ontario. Each of the studies was conducted relatively recently (within the last four years).

Each of the studies chosen for analysis in this section are noted by an asterisk in Table 2.1.

2.4 COMPARISON OF STUDIES

2.4.1 INTRODUCTION

The salient features and results of the five studies relating to the generation of industrial wastes in Ontario are noted in Table 2.1.

In the following subsections, each of the five studies are examined in terms of the type of waste measured, the method of categorization employed, the expected accuracy of the reported results, and the actual magnitude of the waste estimates by industrial sector.

TABLE 2.1 - List of Methodologies

1. Waste Transfer Permit Data

   *MOE Waybill
   California
   McLaren Study

2. Targeted Waste Estimate (Inventory)

   *CCPA Study
   New York Survey
   Canviro Kitchener Waterloo

3. Waste Generation Survey Estimate

   3.1 Jurisdiction Survey
      *Canviro 500
      EPS Atlantic Region
      Illinois Survey

   3.2 Jurisdiction and Other Survey Data
      *OWMC Waste Quantities Study
      Western and Northern Canada Study

   3.3 Other Survey Data Only
      *Gore and Storrie Study
      Mitre Report

*Example study chosen for critical comparison

2.4.2 TYPE AND SOURCE OF WASTE QUANTITY ESTIMATE

Many of the surveys reviewed in Appendix D have estimated somewhat different waste types, having placed boundaries of concern, for a variety of reasons, to include or exclude some waste streams. OWMC, by virtue of their mandate, are interested in all special wastes generated in Ontario. As expected, these were the wastes surveyed in both the OWMC Waste Quantities Study [OWMC, 1982(a)] and the Canviro 500 study [Canviro, 1985].

The Waste Quantities Study reported "total waste generated by industry in Ontario". It was emphasized in that report that a significant quantity of the estimated wastes included wastes treated, disposed, recycled or reused on-site and sewered wastes. The Canviro survey of 500 Ontario firms included a similarly broad range of wastes.

The Gore and Storrie inventory, while defining wastes of interest as 'hazardous and toxic wastes', estimates quantities for all waste streams within the OWMC mandate.

The Waybill System, however, only records data on liquid industrial waste hauled from the generation site by public road to an approved facility. Regulation 313 of the Environmental Protection Act, which covers the transfer of liquid industrial waste in Ontario is shown in Appendix A.

The survey conducted by the CCPA presents figures for the volumes of industrial hazardous wastes generated by those industries surveyed in the Province. However, no indication is given as to what percentage of Ontario industry took part in the survey. The definition of hazardous waste given in this report excluded similar waste streams to those excluded from the Waybill system under Regulation 313:

- wastes which are treated and then discharged along with liquid effluents to the sewer

- wastes that are recycled or reused
- approved wastes going to an approved sewage treatment facility

Both the Canviro 500 and OWMC Waste Quantities studies use extrapolation procedures to arrive at waste estimates for each two-digit SIC group. The OWMC Waste Quantities study employs generation factors based on the results of its own 'ground-truthing' survey as well as factors derived from five other studies. The extrapolation was based on a waste quantity per production employee basis for each four-digit SIC group. The Canviro study uses only that information collected from their own waste survey to calculate generator factors for both two and three-digit SICs. The extrapolation method used in this study is not on a production employee population basis as in the Waste Quantities study, but rather on the basis of numbers of companies within each SIC group. The influence of company size was incorporated to some extent in that study by the division of the SIC groups into two strata, viz. those with more than 10 employees and those with 10 or fewer employees.

The CCPA conducted its survey through eleven trade associations (including CCPA) and Ontario Hydro, and simply aggregated the data collected into twenty-three waste categories. It is not known what percentage of Ontario industry participated in the survey. However, the CCPA, Canadian Fertilizer Institute, Canadian Steel Environmental Association, Motor Vehicle Manufacturers Association, Petroleum Association for the Conservation of the Canadian Environment and Ontario Hydro are believed to have had 100% response rates, while the CMA had a response rate of around 40%.

The Gore and Storrie study established generation factors for ninety-six four-digit SIC groups, based solely on reports (mostly U.S.) published between 1973 and 1980. It did not conduct a survey of its own. Aggregated estimates of hazardous and toxic wastes generated by each SIC group on both national and provincial bases were presented.

Of all information sources for waste generation in Ontario, the Waybill system provides the most reliable figures in terms of real waste quantities generated in the Province which receive off-site treatment. Its major drawback is that it only accounts for those liquid waste streams hauled and disposed of in licensed facilities in Ontario, and does not include any solid wastes, or wastes treated and disposed on site, that might be of interest to OWMC.

Summarizing, the type and source of each waste quantity estimate produced by these five surveys/systems is different. Careful manipulation of figures may allow for some degree of comparison of reported estimates. The Waybill system is very valuable because of the 'reality' of its figures and could be used more as a 'ground-truthing' or testing vehicle by future waste quantity surveys.

It is notable that none of the waste surveys applied an explicit measure of waste hazardousness as a criteria for inclusion in the waste estimates, which was a feature in some U.S.A. surveys of hazardous wastes. The U.S. studies, for the most part, had the benefit of a regulatory scheme for the identification of hazardous wastes, i.e. EPA Resource Conservation and Recovery Act (RCRA). A similar tool is only recently being proposed in Ontario, the Ontario Ministry of the Environment's Blue Print for Waste Management.

2.4.3 WASTE CATEGORIES

Basically, the studies under review use two different waste categorization systems, viz. the UCD and Waybill systems. The UCD system allows for a very detailed breakdown of waste at the three-digit level, while, at the two-digit level, the system provides a degree of detail that is similar to the Waybill classification method. The Waybill categorize waste into twenty-three categories. Descriptions of both systems appear in Appendix B.

Singular or aggregated versions of UCD and Waybill waste categories can be assigned to SIC groups at any digit level. This provides waste generation information on an industry sector basis.

Both the Waybill and CCPA study use Waybill classification, while the OWMC Waste Quantity and Canviro 500 studies use the UCD and UCD in combination with SIC classification systems. The Gore and Storrie report uses only SIC classification and does not categorize waste as other than being hazardous.

The waste categorization schemes employed in each of the waste surveys reviewed here did not explicitly include an indication of waste hazard. The Canviro study results, which have been computerized, did include listings of major waste components and their concentrations, waste flash point, transportation hazard and gross solids contents. These additional factors should permit an analysis of the hazard of many of the wastes reported in the Canviro study.

The Waste Quantities Study presents waste quantity estimates for seventy-nine UCD categories. It then aggregates these waste quantities into fourteen major groups, giving a breakdown based on the physical characteristics (solid, liquid, sludge) of the waste. The most important presentations in this report are two matrices showing the distribution of these fourteen waste categories among:

(1) twenty-one two-digit SIC groups
(2) forty-eight geographic locations

The Canviro 500 report gives very similar breakdowns to these, except that it presents figures for the sample industry group interviewed as well as for the extrapolated situations. The absence of any survey data from the Waste Quantities Study may be attributed to the fact that the data collected had little effect on the waste generation factors employed to produce the waste estimates.

The Canviro 500 study excluded 27 UCD classification numbers from those considered. These were considered not to be "within the OWMC mandate, i.e. not special waste". These wastes accounted for about one quarter of the total reported in the Canviro survey. These same 27 UCD classes were excluded from the OWMC Waste Quantities Study.

2.4.4 METHOD ACCURACY

The accuracy of the methodology employed in any survey ultimately determines the credibility and, therefore, usefulness of the information generated by and conclusions reached from that survey. The methodology used in a waste generation survey can be summarized by the following tasks:

- Sample group select
- Data collection
- Data analyses
- Extrapolation of data

All of these tasks must be tackled in a logical and co-ordinated manner if the survey is to yield worthwhile results.

A few points which should be considered when assessing the applicability of a particular methodology to a survey are:

- The comparability of the data sources - are they reporting on an equitable basis?
- Possible biases in the coverage of industries
- Inaccuracies introduced through misleading or misinterpreted company responses
- Inaccuracies due to the use of two, three and/or four-digit SIC codes. This is particularly important for the Chemical industry

- Inaccuracies due to the assumptions that either waste generation per employee or per plant is constant throughout specific industries; independent of size of establishment or location.

Four of the five waste quantity information sources being reviewed involved a survey; the Waybill system being based on actual records. All four of these surveys used different methodologies.

The methodology selected for the Canviro 500 study required the interviewing of 500 establishments in order to generate sufficiently reliable data to allow for extrapolation of the quantities reported to all of Ontario. Details of the methodology used to select the 500 establishments interviewed can be found in the report [Canviro Consultants, 1985].

Two sets of extrapolations were carried out on the interview generated data. The first included all company data collected; the second excluded four outlier establishments. These outliers were identified as those establishments which had a per production employee waste generation level greater than 75 tonnes. No reasons were given as to why this figure was chosen as the cut-off point.

An examination of these four establishments did not, in our opinion, reveal any evidence that the wastes reported for the four establishments were anomalous. Referring to one specific example, the production of a large quantity of lime waste in the manufacture of acetylene is a normal part of that type of operation. Similarly, metal oxides and waste foundry sands are expected waste streams from many primary metal industries.

These low hazard and large volume waste streams underline the advantages offered by a scheme which would permit the ranking or classification of waste streams by the type and degree of hazard which they present

As noted above, the production of acetylene usually results in the voluminous generation of lime wastes. This type of waste is potentially important to an integrated approach to waste management. This low hazard material has possible benefits in the treatment of other wastes, either through neutralization or solidification. Lime wastes are also considered by acetylene manufacturers to be a growing problem needing a solution. OWMC may be best placed to develop a solution.

It is interesting to note that production employee data were used only at the sample group selection stage of the study. All extrapolations were executed using industry population per SIC group data.

The total waste generated (tonnes/year) by each company in the sample group was calculated from the waste quantities for individual waste streams and by making appropriate weight conversion of Igal, yd^3 or tons to tonnes. This quantity is designated at Y_{ni}. The mean waste generation (tonnes/yr) for any strata h is given by:

$$\bar{Y}_h = \frac{\sum_{i=1}^{n_h} Y_{hi}}{n_h}$$

A sample n_h was selected from each strata h = 1,2,....98

Only two of the four industry sectors selected for interview at the three-digit SIC level appeared in the top five waste generating industry sectors, as reported in the extrapolated results of the survey.

As has been mentioned previously, the waste generator survey conducted for the OWMC Waste Quantities study had only a minor input into

the generation factors used in the extrapolation procedure to generate waste quantity data for Ontario. The survey data were used primarily as a ground-truthing mechanism for the generation factors produced by the five major reference reports used in this study. This is the main difference in methodologies employed by the Waste Quantities and Canviro 500 studies.

The generator factor ground-truthing approach, which was adopted, involved:

"• the analyses of data from surveys conducted in other jurisdictions to estimate waste generated on a per production employee or per plant basis;
• the development of a computer model using these "generation factors" and Ontario estimates of manufacturing employees and plants;
• conducting a survey of manufacturing establishments to "ground-truth" the generation factors and to make adjustments to the model where necessary; and
• predicting the quantity, type and source of waste generated in ontario". [OWMC Waste Quantities Study, 1982].

When selecting the surveys done in other jurisdictions for application to Ontario, a number of factors were stated to have been considered. They were:

"• similarity of the industrial base to Ontario
• degree of waste estimate disaggregation by type
• methodology used in making waste estimate
• date of study" [OWMC Waste Quantities Study, 1982]

As a result, the Mitre Corporation, Northern and Western Canada and the States of New York, Illinois and Minnesota studies were selected for inclusion in the data base.

From Appendix D, it can be read that quite a wide variety of methodologies were used to generate waste quantity data by each of these studies.

The Illinois report used both an extensive survey and hauling permit information to get its waste generation factors. In addition, it surveyed for both hazardous and non-hazardous wastes.

The Mitre report used generation factors derived purely from previous reports and literature.

The New York survey was interested in what it defined as "special industrial waste" which, with a few exceptions, was as described in Section 3001 of Subtitle C, RCRA (1979). [U.S. EPA, 1979]. It sought out those industries, and specific companies within those industries, which would likely generate the greatest quantities of hazardous wastes. The technique of company selection varied depending on the industry sector. As a result of this industry and plant selection procedure, the generation factors developed were biased with respect to any one, complete industry sector. It would seem that the Northern and Western Canada study used the New York generation factors extensively in their waste quantity estimating efforts. Thus, the New York State study had a major influence on the generation factors derived and employed in the OWMC Waste Quantities Study. This is very important since the New York study was distinctly not a statistically random survey.

While the OWMC Waste Quantities Study took into account the differences in productivity between the U.S. and Canada, when calculating its generation factors, it failed to recognize the difference in the level of processing within any one industry sector. This failure is particularly apparent in the pharmaceutical sector, which, in Ontario, is primarily a compounding industry but which, in New York, is a true chemical processing industry.

It is noteworthy that the Waste Quantities Study did not explicitly compare the results of its ground-truthing survey with the wastes predicted by the computer model. Such a comparison could have provided a useful indicator of the accuracy of the estimated waste.

The Gore and Storrie study did not collect any waste generation data of its own, but, rather, relied on data reported in various Canadian and U.S. studies published between 1973 and 1980. These reference inventories were carried out by different researchers using many different methodologies. For use in this study, information presented by each report had to be standardized and a workable format found in order to produce data that could be applied to the Canadian situation. No indication is given as to how the waste generation data from each study was used to find the waste generation factors eventually used in the study. The report does show waste generation factors for each four digit SIC group based on U.S. waste generation data of tonnes per year per employee. Both the Canviro 500 and the OWMC Waste Quantities Study used production employees in their survey methodologies, albeit in totally different applications. However, the latter used a factor derived from Statistics Canada data to calculate production employee numbers from total employee numbers reported by D & B, whereas the Canviro study used both survey generated and D & B employment data. Gore and Storrie assumed equal levels of productivity and processing/manufacture at each four-digit SIC group between Canada and the U.S. The Gore and Storrie study gives a very detailed breakdown of the types of waste streams that are included in each four digit SIC group aggregated waste quantity estimate and also pinpoints the hazardous components which may appear in those streams.

As has been said already, the major drawback to the Waybill system from an OWMC perspective is that, at present, it only records those liquid industrial wastes listed under Regulation 313 that are legally hauled off-site by public road. It is not always necessary for companies to

remove their wastes off-site. Many have sufficient land/storage space to hold on to it for many years. Concerning the actual waste streams recorded, the characterization procedure is not strict and the same waste stream could be classified under a number of categories. Wastes can often be assigned to the wrong category. Wastes that are recycled or reused on-site are not recorded on the Waybill. However, as long as such use of these wastes continue, then they are not of immediate concern to OWMC.

As is mentioned in Appendix D, Regulation 313 is currently undergoing a major revision. In addition to liquid industrial waste and those wastes specified in Clause 24(d) of the Act, site specific wastes and hazardous solid wastes will also come under regulatory control.

Along with the proposed revisions of Regulation 313 is a new proposed waste generator regulation which, it is hoped, will tighten up present waste management practices in Ontario. The proposed regulation will assign more responsibility to the waste generator to ensure that his waste is properly disposed. The proposed regulation reads:

"No generator shall:

(a) store or dispose of liquid industrial waste, site specific waste or hazardous waste; or
(b) permit liquid industrial waste, site specific waste or hazardous waste to pass from his control or to leave the site where it is generated". [Blue Print for Waste Management in Ontario, 1983].

unless he has first applied for and obtained a generator identification number and a waste type number for each type of waste from the Director of the Waste Management Branch of the Ministry.

Nonetheless, the Waybill system records very valuable data with regard to total off-site waste treatment and disposal in the Province, and, with implementation of the proposed improvements, should provide even better information in the future. In particular, since the fate and legal status of the wastes will be defined, the market share for OWMC should be more easily assessed.

It is difficult to comment on the accuracy of the CCPA study because many of the critical survey parameters are not known. The study does not extrapolate data, nor does it indicate what percentage of Ontario industry its waste quantity estimate represents. It provides a general indication of the types and sources of wastes generated in Ontario.

2.4.5 QUANTITIES REPORTED AND VARIATIONS

As can be seen from Table 2.2, the OWMC Waste Quantities, Canviro 500 and Gore and Storrie studies all produced waste estimates of around 1.5 million tonnes/year. These figures were derived by various extrapolation procedures, each of which is explained elsewhere in this report. The CCPA estimate is not an extrapolated figure, but rather an aggregation of reported waste quantities from, unfortunately, an unknown percentage of Ontario industry.

A detailed comparison of waste quantity estimates by two-digit SIC is presented in Table 2.3. Probably the most remarkable figure generated by the Canviro 500 study is the 244,300 tonnes of waste coming from the Stone, Glass and Concrete industry (SIC 32). This represents 15% of their total waste estimate for the Province. Another notable, though less surprising, figure, is the 281,500 tonnes generated by the Transportation Equipment industry (SIC 37). The Canviro study estimated that 32% of Ontario's special waste is produced by these two SIC groups. The OWMC Waste Quantities and Gore and Storrie studies estimated that the same two

industries produce 7% and 0.06% of the total waste output respectively. Although the three total waste estimates for the Province are quite close, when they are broken down to the two-digit level, estimates vary considerably between studies.

Table 2.4 presents the extreme and average waste quantities reported for each SIC group for the three studies. A factor, f, representing the difference in the extreme waste estimates is also shown.

Variations in waste estimates for the Primary Metals (SIC 33), Chemicals (SIC 28), Machinery, except Electrical, (SIC 35), Stone, Glass and Concrete (SIC 32), Leather Products (SIC 31) and Transportation Equipment (SIC 37) are particularly apparent. For SIC 37, the OWMC Waste Quantities estimate was greater than the Gore and Storrie estimate by a factor of 816. The methodology used by one or all of these studies with respect to this SIC group must have been very much astray. The same applies to SIC groups 16, 22, 31, 32 and 35, all of which have "f" factors between 12 and 67. However, for some of these groups, such as SIC 16, 22 or even 31, a flaw in the estimating methodology is not critical to the overall waste quantity estimate for Ontario, because of the insignificance of these industries as waste generators.

When it comes to the major waste generating industries such as the Primary Metals (SIC 33), Chemicals (SIC 28) and Fabricated Metal Products (SIC 34), the "f" factors, though lower, are very critical.

A factor of 2.66 for the Primary Metals Industry represents 478,500 tonnes or nearly 30% of the averaged total waste estimate for the Province.

The sum of the differences between the highest and lowest waste estimates for the SIC groups 28, 32, 33 and 37 represent nearly 95% of the average total waste estimate. This has to call into question the reliability of the total averaged waste quantity.

Although the Gore and Storrie report gave estimates for only twelve SIC groups, its estimates were either the highest or lowest for seven of these groups. Indeed, if the Gore and Storrie estimates for SICs 35 and 37 are ignored, the remaining two estimates differ by factors of 5.5 (from 67) and 3.4 (from 816) respectively.

The problem with the Canviro 500 estimate for SIC 32 can be traced back to their waste survey data. Nine firms and 20 waste streams were reported in the data base of survey results from Ontario industries as being in the two-digit SIC group 32. Four of these firms reported no waste. One firm accounted for 11 waste streams and almost all the waste (more than 99%). Two streams account for 87% of the wastes reported for the two-digit SIC. These are: wastewater contaminated with silver and other inorganic compounds at 4.55 million litres per year, and a wastewater containing one percent oil and grease at 682,000 litres per year. Both these streams are pretreated and discharged to sewer. Two residual streams reported by this firm are a silver salt sludge at 615 litres/yr and an oil and grease stream at 3,070 litres/yr. It is possible that these streams are residuals resulting, at least partly, from the treatment of the voluminous wastewaters noted above. In which case, it is likely that the same wastes have been reported twice in the survey. Also, the two voluminous wastewaters are not appropriately listed as special wastes, since such wastes are typically and effectively pretreated and discharged to sewer.

Both the OWMC Waste Quantities and Gore and Storrie studies report over 500,000 tonnes per year for the Primary Metals Industry, about twice the quantity estimated by the Canviro report. This could possibly be attributed to the fact that both studies rely heavily on U.S. generation factors in calculating their figures, while the Canviro figure(s) is based solely on Ontario interview data. This argument could not hold true, however, for the Chemical industry estimates where the OWMC Waste Quantities and Gore and Storrie studies differ by 540,372 tonnes.

It is interesting to note that only 17.6% of the waste reported by the CCPA survey is waybilled. This is comparable with the Canviro 500 estimate of 16%. Neither figure was verified by the respective studies.

Waybill records for 1982 and 1983 are shown in Appendix C. The total quantity waybilled increased from 228,560 to 327,864 tonnes or by 43%. Significant increases in the quantities waybilled were recorded for the 'other inorganic (190), oily water (201) and other organic (290)' waste categories. A combined increase of 60,143 tonnes in the 190 and 290 waste categories is an indication of some of the difficulties involved in categorizing waste streams by the Waybill system. The increase in volume reported in these two categories represents 60% of the total increase between 1982 and 1983. The amount of waste reclaimed or reused increased from 6.786 million litres to 13.320 million litres, or by 96% over the year. The major increases were recorded for oily water (201), organic solvents (203), acids (101), alkalis (102) and inert sludges (402). The amount of waste going to Tricil landfill dropped from 9.1% to 3.9% of the total quantity waybilled each year. A drop of 6.5% was recorded for wastes going to incineration. A very large increase in the amount of waste going to pollution control plants was recorded between 1982 and 1983; from 4.23 million litres to 20.88 million litres.

TABLE 2.2 - Summary of Total Waste Quantity Estimates

Study	Total Waste Estimate (Tonnes/year)
OWMC Waste Quantities	1,449,300
Canviro 500*	1,645,100 (1,304,100)
Gore and Storrie	1,605,107
CCPA	535,657

*Value in brackets excludes outliers

TABLE 2.3 - Comparison of Waste Quantity Estimates

	SIC No.	Waste Quantity (tonnes/yr)		
		OWMC Waste Quantities	Canviro 500	Gore & Storrie
Primary Metals Industries	33	766,700	288,200 (150,000)	595,384
Chemical Industries	28	146,900	442,400 (239,600)	607,272
Fabricated Metal Products	34	125,200	62,400	170,892
Machinery, except Electrical	35	106,200	19,200	1,583
Paper Products	26	82,700	107,300	29,220
Transportation Equipment	37	82,600	281,500	345
Petroleum	29	62,800	38,600	98,834
Printing	27	20,500	4,400	-
Stone, Glass, Concrete	32	19,500	244,300	669
Electrical Machinery	36	16,200	7,500	2,020
Rubber & Plastics	30	12,700	64,900	-
Non-Building Construction	16	8,900	700	-
Misc. Manufacturing	39	7,800	3,800	-
Food Products	20	7,700	2,900	-
Furniture	25	6,200	13,500	-
Measuring Instruments	38	5,200	3,700	-
Leather Products	31	3,000	59,100	11,448
Textiles	22	1,400	400	7,098
Lumber & Wood	24	1,400	1,100	342
Apparel	23	400	-	-
Hospital	-	2,000	-	-
Others	-	4,100	-	-
Totals		1,490,300	1,645,100 (1,304,100)	1,605,107

Values in brackets are for exclusion of outliers

TABLE 2.4 - Extreme and Average Waste Quantities

SIC No.	Estimate			Largest > Smallest by Factor (f) of
	Largest	Average	Smallest	
33	766,700 (OWMC)	550,095	288,200 (Can. 500)	2.66
28	687,272 (G & S)	425,524	146,900 (OWMC)	4.68
34	170,892 (G & S)	119,497	62,400 (Can. 500)	2.74
35	106,200 (OWMC)	42,328	1,583 (G & S)	67.09
26	107,300 (Can. 500)	73,073	29,220 (G & S)	3.67
37	281,500 (Can. 500)	121,482	345 (G & S)	815.94
29	98,834 (G & S)	66,745	38,600 (Can. 500)	2.56
*27	20,500 (OWMC)	12,450	4,400 (Can. 500)	4.66
32	244,300 (Can. 500)	88,156	19,500 (OWMC)	12.53
36	16,200 (OWMC)	8,573	7,500 (Can. 500)	2.16
*30	64,900 (Can. 500)	38,800	12,700 (OWMC)	5.11
*16	8,900 (OWMC)	4,800	700 (Can. 500)	12.71
*39	7,800 (OWMC)	5,800	3,800 (Can. 500)	2.05
*20	7,700 (OWMC)	5,300	2,900 (Can. 500)	2.66
*25	13,500 (Can. 500)	9,850	6,200 (OWMC)	2.18
*38	6,200 (OWMC)	4,450	3,700 (Can. 500)	1.41
31	59,100 (Can. 500)	24,516	3,000 (OWMC)	19.70
22	7,098 (G & S)	2,966	400 (Can. 500)	17.75
24	1,400 (OWMC)	937	342 (G & S)	4.09
Total	2,675,296	1,613,911	632,390	4.23

*Gore & Storrie report did not provide estimate for this SIC

CHAPTER 3
CRITICAL PARAMETERS INFLUENCING WASTE QUANTITIES

3.1 INTRODUCTION

In this chapter of the report we attempt to examine the four major industrial waste quantity estimates which can be made, viz:

(a) Total industrial waste generated
(b) Total special wastes generated
(c) Total special waste requiring off-site treatment and disposal
(d) Market share of (c) which might come to an individual waste management company such as OWMC.

We then look at the major factors which will influence industrial production of waste, and the major factors which move individual waste streams from, say, being an industrial waste generated to being, say, a special waste requiring off-site treatment.

This exercise is extremely important in formulating an approach to waste quantity estimating, because these factors are dynamic, changing with time. These changes may be step functions rather than smoother predictable trends. For example, changes in legislation may suddenly increase the proportion of industrial waste which is then regarded as special waste.

3.2 WASTE GENERATION CONCEPTS

As was discussed above, we contend that there are four major concepts of industrial waste generation. In Figure 3.1, this is simply illustrated showing the four waste quantity estimates from industry in Ontario, and the fact that these are linked by proportional factors, which reduce the total quantity from the top to the bottom of the diagram. The question marks indicate the types of questions which waste quantity studies try to address. No studies of which we are aware have addressed all four quantity questions and all three proportion questions. Taking the Canviro 500 Study [Canviro Consultants, 1985] as an example, their intent was to estimate Quantity B and C and Proportion C/B. Examination of the data in detail shows, however, that there are some wastes such as sewered wastes and some foundry sands which are not really a part of quantity B or C.

Each of the four waste quantity estimates will be discussed briefly below.

3.2.1 TOTAL INDUSTRIAL WASTE GENERATED

This is an estimate of all wastes generated by industry and might include solid non-hazardous waste, sewered wastes and air emissions. This is a very difficult estimate to come to grips with, as it is most likely to include many anomalies with different people interpreting what should be included in such estimates quite differently. This is particularly so with sewered wastes and air emissions. If one asked the question of industry, "what total wastes do you generate?", some may include air emissions, others not. Some will include sewered wastes, others only residues from any pretreatment processes prior to the stream being discharged to the sewers. Some may estimate the quantity of contaminants in the wastewater stream going to the sewer, and report these on a dry weight basis, e.g. in the pulp and paper industry wastewater quantities are often expressed in terms of kg/day of Biochemical Oxygen Demand (BOD). Similarly, non-ferrous metal

smelters may report sulphur dioxide emissions as so many tonnes/day of sulphur dioxide, and not include the tonnes of nitrogen, carbon dioxide and oxygen in which the sulphur dioxide is contained.

There are, as far as we are aware, no studies which have addressed the question of total industrial waste generated in Ontario. The usefulness of such an estimate to a waste management company such as OWMC could be questioned. However, this estimate would be the only one which would include wastes which are currently not "special wastes" but could, perhaps in the future, become special wastes.

As an example, foundry sand is not currently regarded as a special waste by regulatory authorities in Ontario. It is a solid, generally regarded as being non-hazardous, and currently used as cover material in a number of municipal landfill sites. There is currently debate as to whether this material should be regarded as a special waste. If this were to be the case, the large volumes now being produced in Ontario could dramatically change the need for secure landfill space, or, alternatively, could result in sand recovery systems being installed.

It is probably unimportant for OWMC to have a complete quantitative estimate of this quantity, with all the possible anomalies which would be associated with such an estimate. What is important is to have a qualitative and hopefully semi-quantitative awareness of the possible impacts of future environmental regulations might have on what will become a special waste. For example, we believe that, if more stringent sewer use regulations are imposed, it is most unlikely that the high volumes of very dilute sewered waste will be delivered to OWMC. It is much more likely that industry will respond by introducing waste recovery or, at a minimum, pretreatment resulting in a residue for treatment at an industrial waste treatment facility.

Air emissions obviously cannot be "hauled" to an industrial waste treatment facility. If more stringent air emission standards are introduced, sludges and residues from air pollution control equipment will be generated which may or may not be regarded as special wastes. Flyash, for example, is currently not regarded as a special waste. The product of lime scrubbing of sulphur dioxide would be a flyash/lime gypsum sludge which may or may not be regarded as a special waste in the future.

In summary, we do not believe that it is possible to arrive at an accurate aggregated estimate of this total industrial waste quantity, because of the anomalies of what companies would or would not regard as "a waste". Its usefulness would be of rather academic interest, even if it were possible to make such a quantitative estimate. What is important for a waste management company is to be aware of what industrial wastes not now regarded as special wastes are currently going to municipal landfill sites and what residues might result from more stringent air and water emission control regulations. A judgement must then be made on what proportion of these wastes might become special wastes in the future, and the impact of such changes on the need to provide safe treatment and disposal facilities.

3.2.2 SPECIAL WASTES GENERATED

Special wastes are defined as those wastes currently regarded as falling within the mandate of the Ontario Waste Management Corporation. Briefly, OWMC's mandate could be regarded as being concerned with "Liquid Industrial and Hazardous Wastes". From a practical standpoint, special wastes to OWMC will be those wastes which, if not reused, or recycled, or adequately treated on-site, would be regulated by the Ontario Ministry of Environment into approved treatment and disposal facilities.

This estimate is of the total special wastes generated so it would include wastes generated which are reused, recovered and recycled and those treated on-site. It also includes wastes hauled off-site, both to approved facilities and those currently going to municipal landfill sites.

A number of studies have had an accurate estimate of special wastes generated as their goal. This includes the OWMC Waste Quantities Study of 1982, and the Canviro 500 study.

This quantity estimate is still subject to some anomalies. For example, some companies will regard waste reduction and recovery activities as part of their process and will only report any residues from the waste reduction processes as waste. Others will regard waste reduction as a waste treatment process and will report the quantity of waste prior to waste reduction. Some companies will still report sewered waste, while others only residues from pretreatment processes applied to wastewaters prior to sewering. The anomalies are much less severe in this estimate than in trying to estimate total wastes generated.

This is a much more important estimate for a waste management firm to have as accurately as possible. It defines the "ultimate potential market" for waste treatment and disposal for those wastes currently regarded as special wastes. The likelihood of that "ultimate potential market" ever being reached is very, very small. However, if a waste management company, say, offered to take wastes from a plant absolutely free, then a plant might well abandon its on-site treatment process in favour of allowing an outside company to come and pick up his untreated waste. This is obviously not going to happen, but, in a facetious way, it illustrates the point.

In summary, this is a very important estimate for any waste management company to have to understand their potential market. Equally important to the estimate is an understanding of the current fate of wastes included in that estimate which will include special wastes currently going to off-site treatment and disposal, which is discussed below.

3.2.3 SPECIAL WASTES REQUIRING OFF-SITE TREATMENT AND DISPOSAL

This estimate is subject to the least anomalous reporting. If special wastes have been well defined, then any company should know how much of this material is hauled off-site in trucks or trains. Whether it is pretreated, dry or dilute, this is the form in which it leaves the site, and, therefore, this is the quantity of waste requiring off-site treatment and disposal.

Many estimates of special wastes requiring off-site treatment and disposal have been made in other jurisdictions in both North America and Europe. Most of these estimates are for countries, states and provinces with a similar level of industrial development as Ontario. There is a remarkable consistency in the estimated per capita quantity of industrial waste requiring off-site treatment and disposal. Many of these estimates are based on actual receipts at treatment and disposal facilities, so that the data are felt to be very valuable.

Table 3.1 summarizes the information which has been extracted from the reports reviewed in Appendix D of this report. Using a population figure of 8 million for Ontario, the range of waste quantities requiring off-site treatment and disposal would be from 222,000 to 320,000 tonnes with an average of about 280,000 tonnes. This is a much more realistic figure of "ultimate potential market" for any waste management company than the special wastes generated estimate. The value of this highly aggregated waste quantity estimate is discussed in Appendix D as being limited. However, the consistency in jurisdictions similar to Ontario in both industrial development and level of environmental concern would suggest that this cannot be ignored as a benchmark against which to judge more detailed estimates. For example, if a detailed estimate of special wastes requiring disposal in Ontario came up with answers of 100,000 tonnes/year or 600,000 tonnes/year, one might question the accuracy of the estimate based on our benchmark of 280,000 tonnes $\pm$ 20%.

It is recognized that this quantity estimate will be dynamic with time. As will be discussed in Section 3.3 and 3.4, the factors which will influence this quantity will result in both increases and decreases in the total quantity. What may be much more significant is the change over time of the components making up the total waste quantity. For example, waste disposal companies have already seen a dramatic decline in the quantities of organic liquids available to them for treatment and disposal. At the same time, however, more stringent sewer use by-laws are increasing the amount of pretreatment of sewered waste, which has resulted in some increases in the quantities of inorganic sludges requiring treatment and disposal.

In summary, it is felt that this estimate is the one which can be made most readily with a minimum of anomalies in any reported data. Analysis of data from other jurisdictions suggests that an aggregated estimate of the total quantites requiring off-site treatment and disposal of 280,000 tonnes $\pm$ 20% can be predicted for Ontario. Waybill data in liquid wastes for 1982 and 1983 (see Appendix C) falls more or less within this predicted quantity range.

3.2.4 MARKET SHARE FOR AN INDIVIDUAL WASTE MANAGEMENT COMPANY

This is a difficult quantity to discuss in general terms as it will be so dependent upon the policies and capabilities of the particular waste management company. To consider this specifically for OWMC is beyond the scope of the present study and will be the subject of a subsequent study in a series of projects which will be leading to OWMC's initial facility capacity estimate.

It is obviously a most important quantity estimate for OWMC or any waste management company to project what the market for their services is likely to be. For the present study, however, we will restrict our consideration to what factors will influence this quantity. These are discussed in the following sections of this chapter.

FIGURE 3.1 - Summary of Parameters Involved in Waste Quantity Estimated

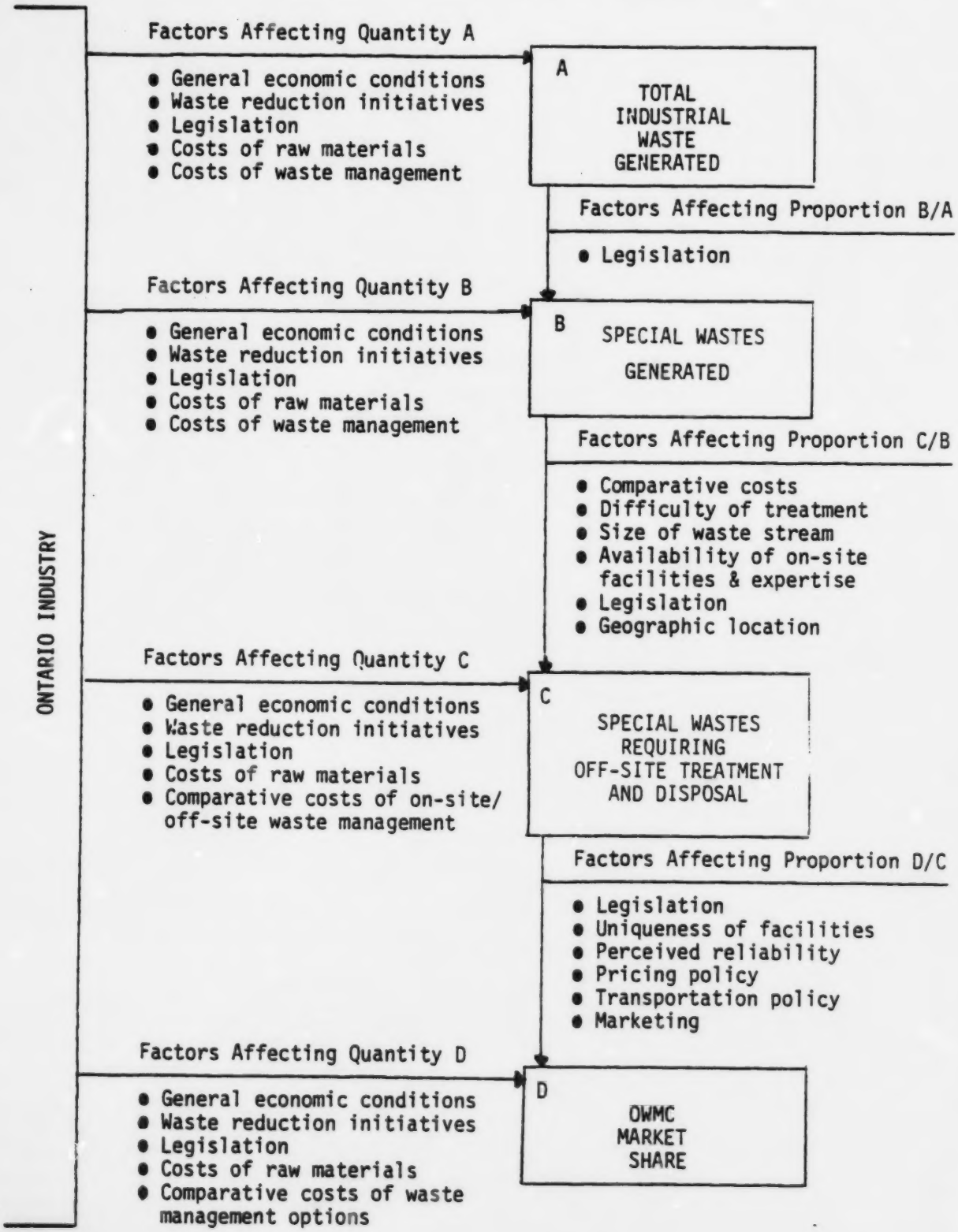


TABLE 3.1

Jurisdiction	Per Capita Generation Rate of Special Wastes Requiring Off-site Treatment kg/year
California	38.5
New York	27.8
Hessen, West Germany	40.0
Bavaria, West Germany	31.7
England	35.7
France	37.4
Sweden	33.3
Netherlands	35.7
Average	35.1 + 4.9 - 7.9

3.3 FACTORS AFFECTING INDUSTRIAL WASTE GENERATION

In Figure 3.2, the major factors which affect the quantities of waste generated by industry are shown for the four waste quantity estimates. Many of the factors are common to all four waste quantity estimates, and will be discussed generally below as they apply to each estimate. It is recognized that many of these factors are interrelated, but are separated for simplicity in discussion.

3.3.1 GENERAL ECONOMIC CONDITIONS

The general state of the economy will have a marked influence on the generation of waste. In a depressed economy, when production levels are cut back, the generation of waste will, in general, also be reduced. Contrary to this general trend, a few cases may be found where waste generation may increase because of poor market conditions. An opinion expressed during an industry interview during the OWMC Waste Reduction Opportunities Study [OWMC, 1983, 4-46] illustrates this point: "An interesting minority opinion was expressed by one manufacturer who reported that his ability to effectively reduce waste generation was impaired by short production runs caused by soft market conditions."

In addition to the effect on production levels, a depressed economy may encourage companies to examine waste management practices as part of an overall programme to reduce costs. Initiation of waste reduction or waste reuse practices will further reduce the quantities of waste being produced or, at least requiring safe treatment and disposal.

A depressed economy can have a negative impact on waste reduction activities. An example, not involving special waste, illustrates this effect. A small company built up a business to produce fireplace logs based on wood waste (sawdust and shavings) from furniture and roof-truss manufacturers. During the 1982/83 slowdown in the Canadian economy,

consumer demand for furniture and new houses was severely affected. Demand for lower cost items such as fireplace logs, however, was relatively unaffected. Thus, the small manufacturer had the dilemma of a sustained demand for his product, but no supply of raw materials. Companies planning to utilize wastes as a raw material, therefore, should carefully consider the unequal impact of a depressed economy on supply of raw material and demand for their product.

The effect of a booming economy will, in general, produce increasing quantities of waste since more production generally means more waste. As waste generation increases, however, and becomes a more significant operating cost, this may encourage companies to consider better waste management practices. As the volumes of waste increase, waste reduction processes which were not technically or economically justified at lower generation rates may become attractive.

3.3.2 TECHNOLOGICAL CHANGES AND CHANGE IN PROCESS AND PRODUCT MIX

In the longer term, there will be changes in technology and in the industrial product and process mix which will influence both the nature and quantities of industrial waste. As an example, the change from a coal-based to petroleum based chemical industry has dramatically changed the quantities and nature of industrial wastes generated. The textile industry, as a second example, has gone from one based largely on natural fibres such as wool, cotton and silk, to one based on petroleum derived polymeric materials such as nylon, polyester, acrylics, etc.

These technological changes may also result in a geographic shift in the generation of wastes, e.g. nylon yarns are produced in Ontario, while cotton yarns and cloth are imported.

With industrial waste management becoming an increasingly significant cost of doing business, minimizing waste production in the

adoption of these technological changes should be an increasingly important factor in deciding upon the implementation of change.

3.3.3 WASTE REDUCTION INITIATIVES

The effect of industries undertaking waste reduction initiatives will, by definition, reduce the volumes of waste requiring safe treatment and disposal. It should be recognized, however, that some of these initiatives will reduce the volume of the waste, but not necessarily reduce the components of concern. Some waste reduction initiatives will reduce a high volume pumpable liquid waste stream to a few drums of non-pumpable sludge.

While all waste reduction initiatives are to be encouraged, one must thoroughly understand their effect on waste quantities. It is not enough to report that waste stream X has been reduced by 99%. The new waste stream may only be 1% of the volume of X, but it may contain all the elements of concern in a concentrated residue, which, from a materials handling point of view, is much more difficult to deal with because it has "gone solid in the bottom of this battered 45 gallon drum". Whether on-site or off-site treatment and disposal is considered for that residue, it is not necessarily only 1% of the problem which it was prior to waste reduction initiatives being undertaken.

Other waste reduction initiatives which change the primary industrial process itself may, indeed, completely eliminate waste streams. Use of dry powdered coatings in place of solvent based paints is an excellent example of this. Powdered coatings are applied using electrostatic forces. The powder is charged in the spray nozzle and the item to be coated is given an opposite charge. Any powder not adhering to the target is recycled. Baking of the item melts and spreads the coating. This substitution completely eliminates the production of paint sludges, a rather difficult to handle industrial waste stream.

The recycling industry is an important part of the waste reduction scene. They operate large volume throughput waste recycling facilities, which would be uneconomic for individual companies to consider. It is important when considering waste quantities not to forget to consider the residues from the recycling industry. It was interesting to note from a survey of the Ontario recycling industry reported in the Waste Reduction Opportunities Study [OWMC, 1983] that very little of the residues from this industry required off-site waste treatment facilities. Much was being used as an energy resource or incorporated into low grade products. There was, however, some material being disposed at municipal landfill sites, which may not be permitted in the future.

An active recycling industry exists in Ontario for the following wastes:

Lubricating oils
Oily water
Solvents
Pickle acids
Precious metal sludges
Photographic wastes
Tin bearing sludges and liquids

as well as for the traditional solid wastes of scrap metal, paper and plastics.

A number of the factors discussed elsewhere in this section influence companies to consider waste reduction initiatives, including legislation and the cost of waste management. In addition, there are other factors which can increase the adoption of waste reduction approaches:

(a) The development of practical technical solutions to specific waste problems

(b) The dissemination of information about waste reduction opportunities.

The latter is particularly important for small to medium sized industry, and it is being addressed by a number of Canadian initiatives such as the Canadian Waste Materials Exchange, the Ontario Waste Exchange, and reports such as Profit from Pollution Prevention [Campbell and Glenn, 1982], and Industrial Waste Prevention in the Region of Kitchener/Waterloo [RIS et al, 1984].

In summary, it is believed that there will be an increase in the adoption by Ontario industry of waste reduction initiatives which will, in general, lead to an overall decrease in the volumes of industrial waste requiring safe treatment and disposal. However, such activities may lead to the generation of other residual waste streams which do require safe treatment and disposal.

3.3.4 LEGISLATION

Legislation can have a major influence on quantities of waste generated by industry. When wastewaters could be released, untreated, to watercourses and sewer systems and any industrial residues could be buried or sent to municipal landfill sites, there was very little incentive for industry to minimize the quantities of those wastes.

Today, these practices are totally unacceptable for those industrial wastes designed as special wastes. Legislation is in place requiring industry to safely treat these wastes and to direct residues to special industrial waste disposal sites, or to have acceptable on-site disposal.

There are two parts to legislative influence, policy and policing. Ontario has a clear policy today of restricting the disposal of

industrial special wastes in municipal landfill sites. Because of the current lack of facilities for certain of these types of wastes, they have been unable to effectively police that policy. With the opening of OWMC's treatment and disposal facility, this barrier to effective policing of the policy will be removed.

The effect of effective policing of legislative policy on the safe treatment of special wastes, on quantities of those wastes generated by industry is indirect. The costs for safe treatment and disposal either on-site or off-site will be much higher than for traditional disposal methods. These additional costs will encourage industry to re-examine their waste generation practices to minimize these costs.

Some jurisdictions, notably California and New York State, are attempting to directly legislate waste reduction and recycling by requiring companies to show why they cannot reduce or recycle their wastes, prior to being permitted to dispose of such wastes. This is an interesting concept not yet being tried in Ontario, but it is not anticipated to have as great an influence on waste quantities as the indirect effect of legislation requiring industry to use approved treatment and disposal methods.

Legislation can result in increased quantities of waste by negatively influencing waste reuse and recycle initiatives. Parts of the U.S. EPA's Resource Conservation and Recovery Act [U.S. EPA, 1979] are actually hindering the reuse or recycle of potentially useful waste streams, because of onerous restrictions placed on the potential users. These restrictions were put in place to tightly control waste treatment and disposal facilities. Their universal application, however, is discouraging industry from accepting reusable wastes.

Unreasonably tight product and raw materials standards can also increase waste quantities. Rejection of very slightly off-spec materials which do not meet overly tight standards leads to the generation of a waste

stream, which might, in fact, have been a product. Similarly, overly tight specifications on raw materials may eliminate a potentially useful waste stream from consideration as a substitute raw material.

Increasing environmental standards for air and water emissions will lead to treatment of those streams, which will, in all probability, result in the generation of additional quantities of special wastes.

3.3.5 COSTS OF RAW MATERIALS

The costs of raw materials for an industrial process have a marked influence on the quantities of wastes generated from that process. A visit to a manufacturer of gold jewellery will vividly illustrate this point. All scrap materials produced from machining and polishing of the gold are gathered together for recycle. One employee is constantly vacuuming the area to capture any dust generated by these operations. Even in the washrooms, the hand basins drain into a solids recovery system to extract the minute quantities of gold which were adhering to the workers' hands.

The rapid escalation of oil prices in the early to mid 1970s resulted in a marked reduction in the production of waste oils and solvents. Waste reduction, reuse and recycle initiatives were all suddenly very attractive because of the increased cost of virgin oil raw materials.

Thus, increasing raw materials costs, particularly when those increases are much greater than general upward inflation, will tend to decrease the quantities of wastes generated by industry. In extreme cases, industry will substitute alternative raw materials to replace the now too expensive feedstock. This will result, hopefully, in a reduction of wastes generated or it will certainly change the nature of the waste from that process.

3.3.6 COSTS OF WASTE MANAGEMENT

In this section, we will consider the three factors associated with costs which are shown on Figure 3.2:

- Costs of managing wastes
- Comparative costs of off-site vs on-site treatment
- Comparative costs of individual waste management companies

The first factor is generic to all waste quantity estimates, while the second two are specific to "Industrial Special Wastes Requiring Off-site Treatment and Disposal" and "Market Share for Individual Waste Management Companies", respectively.

The cost of waste management is a most important factor influencing waste quantities. It is affected by legislation, as was discussed in Section 3.3.4, and it, in turn, then affects industries' decision to undertaken waste reduction initiatives as discussed in Section 3.3.3.

Prior to the 1970s, industrial waste management was not a significant cost element in any company's cost of doing business. Today, the immediate cost of safe treatment and disposal and, perhaps, the more significant threat of long-term liability for unsafe treatment and disposal practices, is making industrial waste management a much more important part of today's industrial balance sheet.

In becoming a significant cost element, more importance is attached to examining ways of reducing those costs, which, in general terms, can best be achieved by reducing the quantities of wastes.

The quantity of waste requiring off-site treatment and disposal will be influenced by the comparative costs of off-site vs on-site treatment. As a generality, larger companies with larger waste quantities

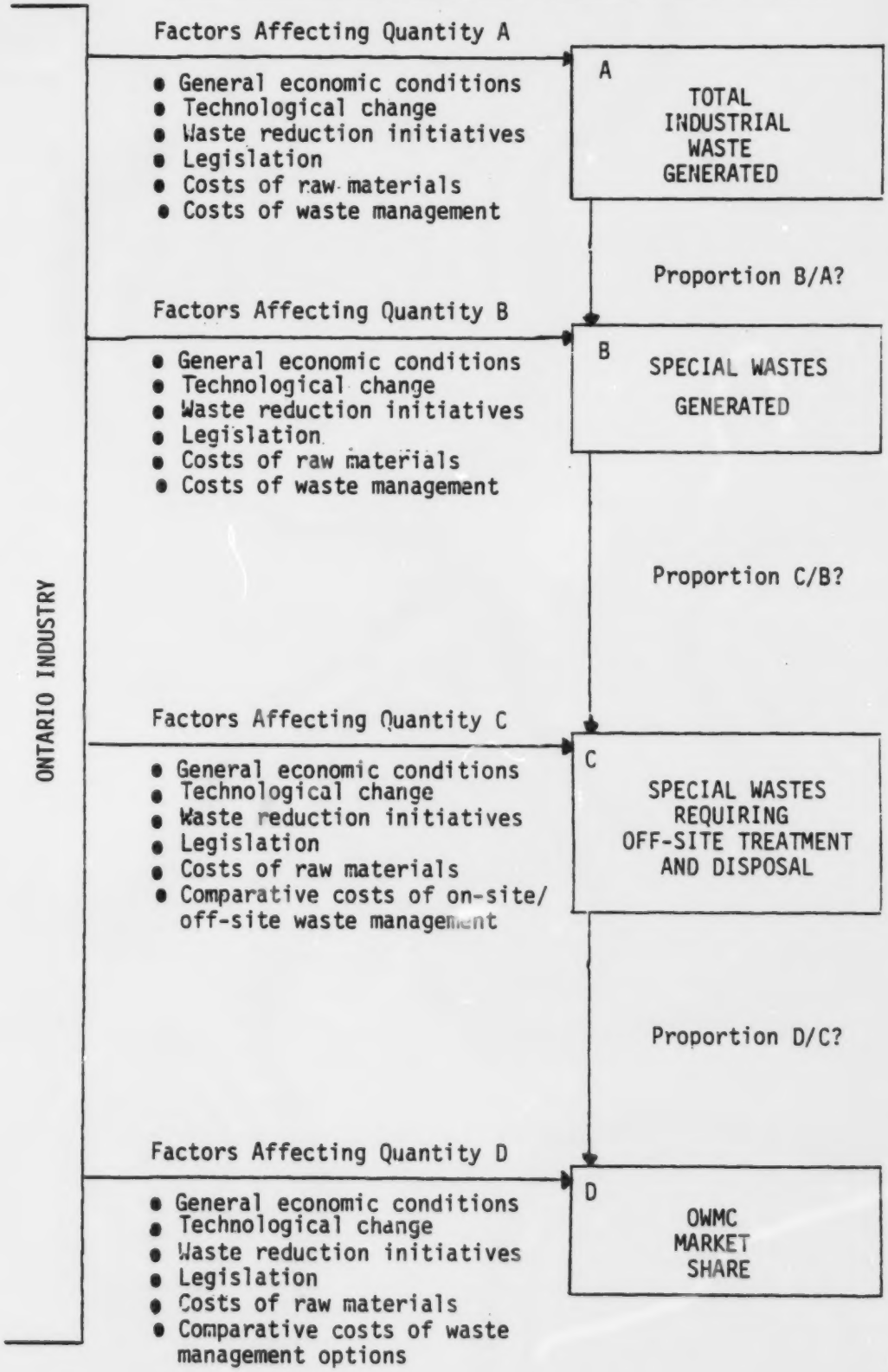
are more likely to be able to economically treat wastes on-site, than would smaller companies with smaller quantities of wastes. As the cost of off-site treatment escalates, so industry will constantly re-evaluate the on-site treatment and disposal option.

If two waste management companies are both perceived to be able, and licensed, to safely treat and dispose of a particular waste stream, a very simple economic decision will be made by industry to send that waste to the waste management company charging the lower price.

It is the influence of the cost of waste management on waste quantities which makes it difficult for an organization like OWMC entering the marketplace to make an accurate estimate of waste quantities. The major impetus to establish OWMC in 1981 was because no alternative to municipal waste disposal sites seemed to exist in Ontario for a proportion of the special waste being generated. When OWMC's facilities are opened, the costs associated with waste treatment and disposal will be considerably higher than those associated with current landfill disposal. As was discussed in previous paragraphs, this will then affect the quantity of waste generated, making an initial estimate of waste based on the current situation inaccurate.

Experience in Europe has shown that initial waste quantity estimates carried out by waste management companies, prior to their entering the marketplace, were consistently high. The quantity of wastes requiring treatment and disposal at their facilities, after they were opened for business, were as little as half of the original estimate [OWMC, 1982(b)].

FIGURE 3.2 - Factors Affecting Quantities of Wastes Generated by Industry



3.4 FACTORS AFFECTING THE RELATIONSHIP BETWEEN WASTE QUANTITY ESTIMATES

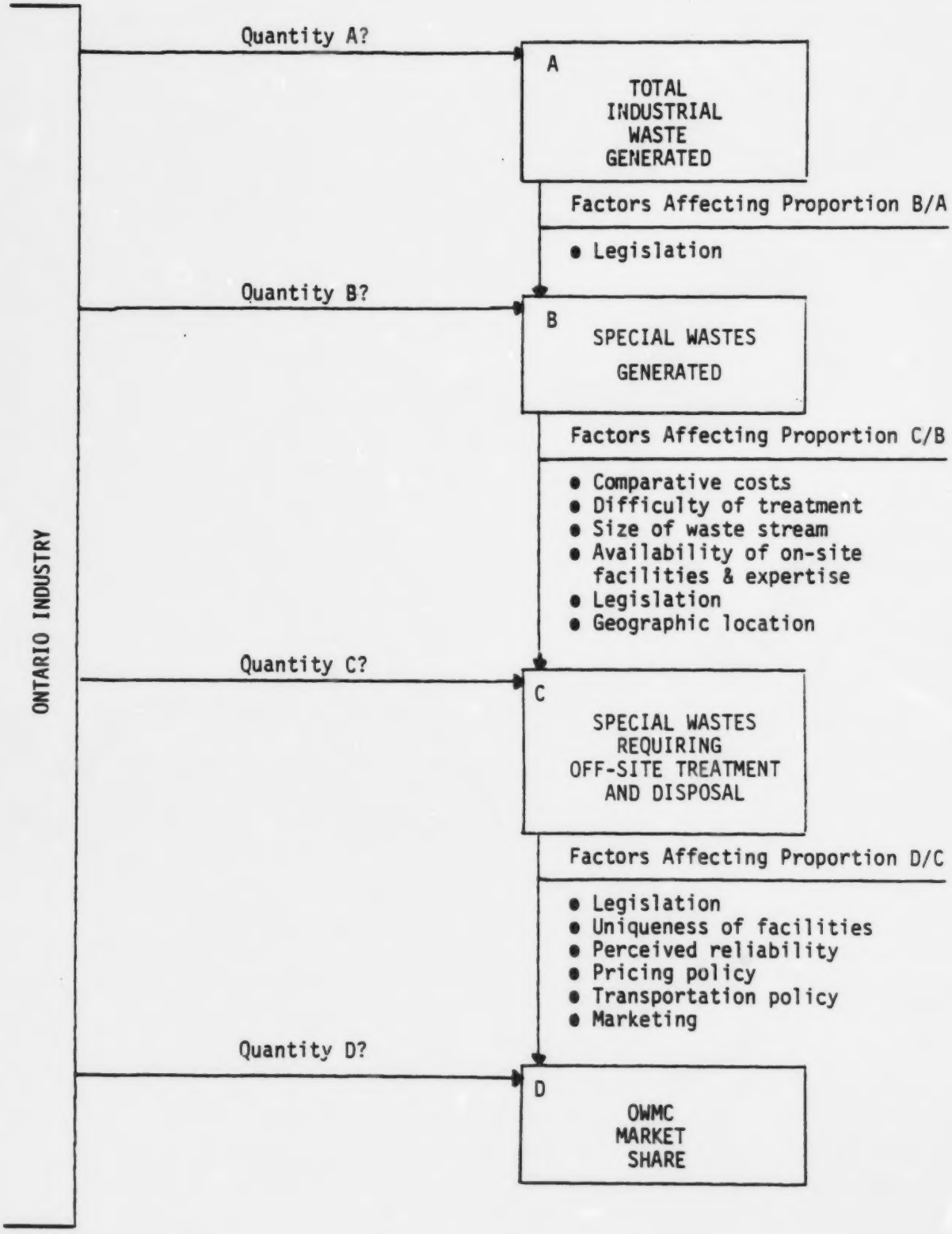
In Figure 3.3, the factors which determine the proportions of total industrial waste becoming a special waste, a special waste requiring off-site treatment and market share for an individual waste management company are listed. Since these are quite different for the three proportions to be estimated, the discussion below will be subdivided by the proportion being addressed rather than the individual factors.

3.4.1 FACTORS AFFECTING THE PROPORTION OF WASTE WHICH IS DESIGNATED AS A SPECIAL WASTE

There is really only one factor which influences this proportion, and that is legislation. Legislation which is put in place to protect human health and the environment will designate certain industrial waste streams as "special wastes" or any synonym such as "waste of concern", "hazardous waste", "potentially hazardous waste" or "liquid industrial and hazardous waste". It will regulate those wastes to be handled with special care and not be disposed of through the traditional channels of waste disposal such as sewage treatment plants or by co-mingling with domestic garbage.

In our definition of Total Industrial Waste Generated (Section 3.2.1), we suggested that this included sewered waste, while special wastes (Section 3.2.2) did not include sewered wastes. More stringent sewer use legislation will lead to pretreatment requirements which will include residues which will increase the quantities of special wastes. Similarly, more stringent air pollution requirements may influence the quantity of special wastes by producing sludges and residues from emission control measures.

FIGURE 3.3 - Factors Affecting Relationships Between the Quantity of Waste Estimates



An accurate definition of special waste is the subject of a separate and parallel study for OWMC. The Ontario Ministry of the Environment will be the final arbiters of what constitutes a special waste through their legislative authority. It must be stressed, however, that this is unlikely to be a stationary definition. With increasing public expectations in environmental protection, wastes not considered to be special wastes today may be regarded as special wastes in the future.

3.4.2 FACTORS AFFECTING THE PROPORTION OF SPECIAL WASTES REQUIRING OFF-SITE TREATMENT AND DISPOSAL

There are a number of factors which affect a company's decision to employ an off-site waste management firm to deal with their special waste. All of these factors are really part of a comparison of costs. Thus, the six factors listed on Figure 3.3 might be listed as comparative costs with 5 subcomponents.

Comparative Costs:

- difficulty of treatment
- size of waste stream
- availability of on-site facilities and expertise
- legislation
- geographic location

3.4.2.1 Difficulty of Treatment

For very difficult to treat waste streams, it is likely that specialized waste management firms could offer to treat such streams at a more competitive cost than could an individual company. If the stream is unique to that particular company, however, this generalization may not be true.

Another advantage a waste management company enjoys in some instances is being able to treat wastes with wastes. For example, acid wastes from Company A can be neutralized with alkaline wastes from Company

B. Programmes, such as the Canadian Waste Materials Exchange, attempt to make companies directly aware of available wastes to allow them to take advantage of this option on-site.

3.4.2.2 Size of Waste Streams

This is a major factor in determining whether to set up on-site waste treatment and disposal. In general terms, very small quantities of waste or huge quantities of wastes are likely candidates for off-site treatment and disposal. For small quantities of waste, it is probably uneconomical to consider on-site treatment and disposal. For very large quantities of wastes requiring ultimate disposal, limited property sizes would suggest seeking off-site disposal facilities. For quantities between these extremes, the decision will be dependent upon other factors discussed here.

Sizes of waste streams can be, to some extent, associated with the size of company producing them. In the recent study by Canviro, interviewing 500 companies in Ontario [Canviro, 1985], they concluded that small companies (less than 10 employees) generate only about 40,000 tonnes per year of special wastes. While this amounted to only 2.5% of the total estimated waste generation for Ontario, it is likely that a very high proportion of this waste quantity would go to off-site treatment and disposal, a much higher proportion than for the other 97.5% of the quantity of special waste generated by larger companies.

3.4.2.3 Availability of On-Site Facilities and Expertise

This, too, is likely to be to some extent a function of company size. A large integrated steel company is much more likely to have both facilities and expertise in-house to safely treat and dispose of wastes, than, say, a small custom electroplater. However, even the large integrated steel companies are selective about which waste streams they deal with in-house and which they have treated and disposed through the commercial waste management industry.

3.4.2.4 Legislation

Legislation which regulates the safe treatment and disposal of special wastes will also influence the decision as to whether to treat wastes on-site or off-site. For example, the requirements to get an approved facility for the destruction of PCBs would make almost all companies decide to have PCBs dealt with off-site. Other similar concerns and requirements for approval of other waste treatment and disposal facilities will also influence the comparative costs of on-site vs off-site treatment. This, in turn, will influence an individual company's decision about an individual waste stream.

3.4.2.5 Geographic Location

The location of a plant in relative terms to existing waste management companies will also be a factor in determining whether off-site treatment might be considered. If the plant is located too far from existing facilities, transportation costs may become the dominant cost element for off-site waste management.

3.4.2.6 Summary

In summary, all of the five individual factors influence the comparative costs of on-site vs off-site treatment. When the costs are computed, the least cost option will generally be chosen. The one caveat on that simple economic decision is that, if off-site treatment is chosen, the waste generator is satisfied that the waste management company can, indeed, take care of the waste stream. Generator liability for wastes, even after they have left his site, is making companies much more careful about choosing reliable treatment and disposal facilities.

3.4.3 FACTORS AFFECTING THE PROPORTION OF THE OFF-SITE TREATMENT MARKET WHICH WILL BE AVAILABLE TO A SPECIFIC WASTE MANAGEMENT COMPANY, i.e. OWMC

The uniqueness of OWMC as a waste management company has dictated that this section be written in more specific than general terms. Many of the factors discussed below would, however, also apply to other waste management companies.

Six factors are considered below, which will affect the market share of the off-site waste treatment business that OWMC might expect.

3.4.3.1 Legislation

The legislation creating OWMC set it up with a mandate for the implementation of an Ontario-wide programme for the management of special waste. The current legislation does not direct that specific wastes must be treated by OWMC facilities. It is conceivable that some future legislation may be promulgated or regulation of current legislation may be interpreted to direct specific, extremely difficult to handle, or extremely hazardous wastes to the OWMC facilities.

Current requirements for approval and licensing of facilities are essentially preventing private sector waste management companies in Ontario from seeking approval to manage wastes beyond those which they currently handle.

3.4.3.2 Uniqueness of Facilities

Unique capabilities to handle certain specific waste streams will certainly ensure that all of these wastes requiring off-site treatment should be available to OWMC. Current waste management facilities in Ontario are unable to handle a number of types of waste, including:

- Non-pumpable organic sludges
- Organic wastes containing significant concentrations of halogens
- Polychlorinated biphenyls
- Cyanide containing wastes

If OWMC were to include a rotary kiln incinerator in their facility with appropriate acid gas cleaning equipment, they would have a unique facility in Ontario to handle organic sludges and halogenated organics. This unit could also, if approvals were obtained, handle polychlorinated biphenyls, if designed with appropriate combustion temperatures and residence times.

A cyanide destruction facility would also be unique in terms of the off-site waste management industry. Hydrolysis, alkaline chlorination, and bisulphite treatments have all been shown to be effective processes for cyanide destruction.

While a secure industrial waste landfill is currently available in Ontario, the company operating this facility has not been actively seeking large volumes of industrial inorganic residues.

If OWMC establish a physical/chemical treatment facility, sludge solidification and secure landfill site for treated inorganic residues, they will not have a unique facility, but one in a market which is not being aggressively pursued by Ontario-based waste management companies. If a slightly more global view is taken, however, the Stablex facility in Blainville, Quebec, is certainly aggressively seeking inorganic waste streams. Waste management companies in neighbouring States of the U.S.A. can also provide some of the facilities which OWMC might possess uniquely in Ontario.

Any excess capacity for waste treatment and disposal in the manufacturing section in Ontario, (IF permits could be obtained to accept industrial waste from other generators [a big IF]), may also take away from the uniqueness of OWMC facilities.

3.4.3.3 Perceived Reliability

The long term liability of waste generators for the consequences of any damage resulting from their waste, even after it has been taken by a waste management facility, makes the perception of reliability of such companies an important factor in selecting an off-site waste management company. Without casting any aspersions on the present Ontario Waste Management industry, the association of OWMC with the government of Ontario may encourage companies to view OWMC as minimizing any long term liability risk to them.

3.4.3.4 Pricing Policy

This is almost certainly the single most important factor in determining market share. Industry will, by and large, choose the least expensive reliable facility which is able and licensed to handle their particular waste stream. This is a complex and sensitive issue, particularly for a Crown Corporation such as OWMC.

3.4.3.5 Transportation Policy

This is really a part of the pricing policy, but is separated out as it may be particularly important for companies geographically far removed from the OWMC facility. If OWMC's decision on transportation is to rely on the existing waste hauling industry, the costs for a company in Thunder Bay to ship wastes to the chosen OWMC site in the Golden Horseshoe area of Southern Ontario will be much higher than for a Hamilton based company shipping the same waste. If OWMC has its own transportation network, or if they contract existing waste haulers to work for them, recharging costs to customers, the possibility exists to even out transportation costs throughout the province. Such a policy is in place in the GSB system in

Bavaria, West Germany. Collection stations exist throughout Bavaria. Companies are charged the same for wastes entering the system anywhere in Bavaria, no matter how far from the treatment and disposal facility. This decreases the costs for wastes far from the facility, while increasing costs for wastes located geographically close to the site.

This factor has to be considered as part of the pricing policy in light of the geographic distribution of special wastes requiring off-site treatment facilities.

3.4.3.6 Marketing

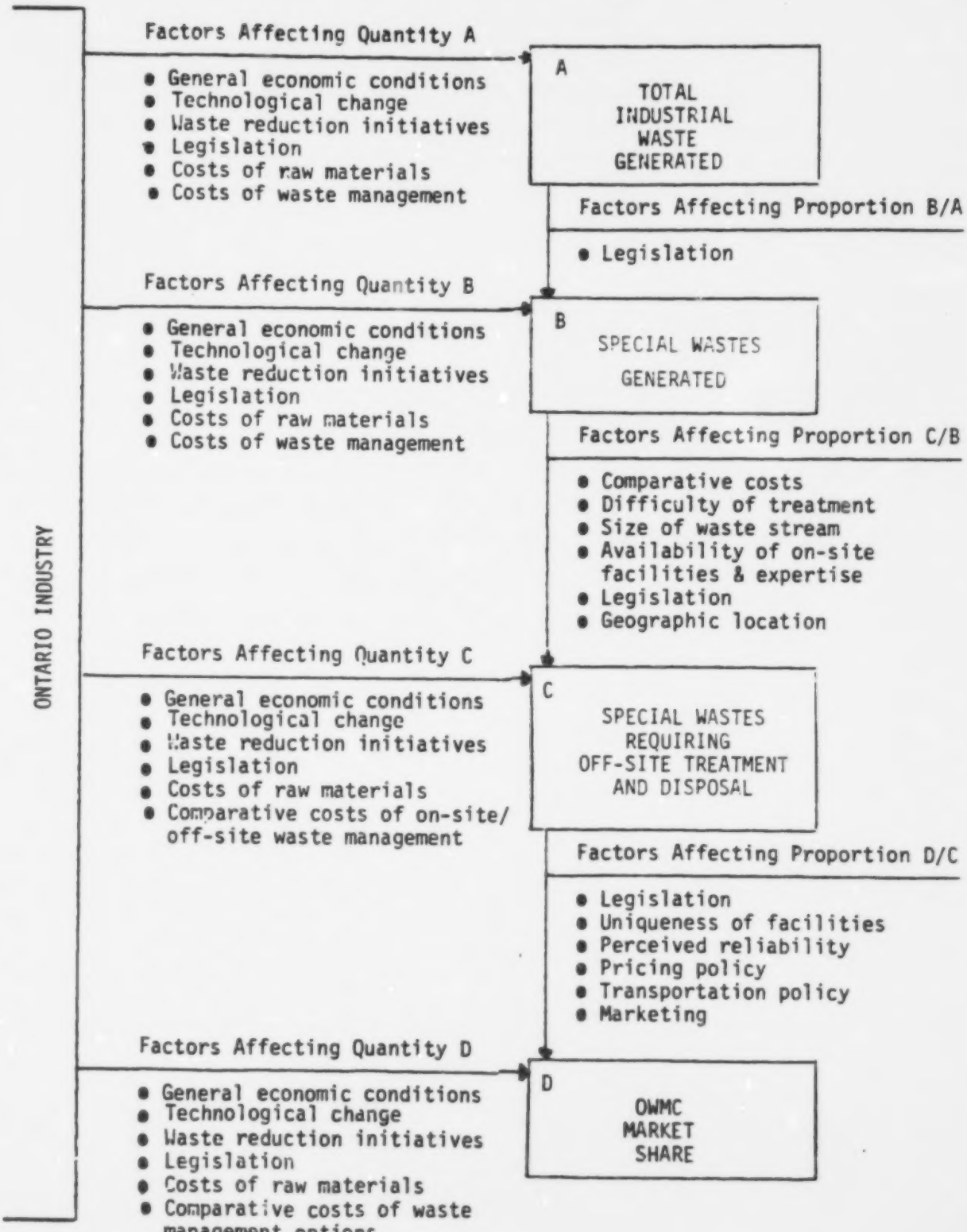
Marketing strategy is another factor which can have an influence on the market share for OWMC or any individual waste management company. Marketing strategy will include many of the factors discussed above. A decision will have to be reached on OWMC's policy, viz-a-viz. an aggressive marketing stance in direct competition with the private sector waste management industry.

3.5 SUMMARY

Figure 3.4 summarizes the factors discussed above and introduced in Figures 3.2 and 3.3. There is a very complex relationship between these factors and the waste quantities which they influence. These factors and their relationships will vary with time, thus making prediction of future waste quantities even harder than predicting current waste quantities.

While it is dangerous to generalise, it is reasonable to state that industry will choose the least cost, legal and reliable approach to management of their wastes. Almost all of the factors in Figure 3.4 can be reduced to having an economic consequence.

FIGURE 3.4 - Summary of Parameters Involved in Waste Quantity Estimates



Future trends in most of the factors are to increase costs for waste management and disposal and for the raw materials going in to those processes which will produce the wastes. This trend will tend to reduce the quantities of waste produced as waste abatement and reduction practices become economically attractive.

Tougher environmental legislation may result in increased quantities of waste residuals resulting from air and water pollution control measures.

The influence of general economic trends is beyond the scope of this study. Canada is still predicting real growth in the economy. However, trends seem to be going to low or negative growth in the "waste producing" industrial sector. Ontario's economic growth is more likely to be in the service sector which produces little or no special waste.

CHAPTER 4
PROPOSED APPROACH TO WASTE QUANTITY ESTIMATES

4.1 INTRODUCTION

In this final chapter of the report, we attempt to establish an approach to refining and improving the current waste quantity estimates available to OWMC.

Prior to describing the recommended approach, a summary of the major factors which have led to the shortcomings in the current estimates are reiterated from earlier parts of the report. These are summarized in Section 4.2 under 5 major headings. Particular emphasis is placed on the OWMC Waste Quantities Study and the Canviro 500 estimates.

4.2 MAJOR FACTORS LEADING TO SHORTCOMINGS OF THE CURRENT ONTARIO WASTE ESTIMATES

4.2.1 LACK OF A CLEAR DEFINITION OF "SPECIAL WASTES"

This has led to a great deal of confusion as to what should or should not be incorporated into any waste estimate. As was discussed in Section 3, the only practical factor which determines that an industrial waste is a special waste is legislation. In the United States, the U.S. EPA defines regulated wastes in their RCRA regulations. This is a combination of

individually listed waste streams and degree of hazard rating for non-listed wastes. Ontario does not currently have similar well defined regulations in place. The Ministry of the Environment's Blue Print for Waste Management in Ontario puts forward proposals to define wastes under three categories:

Special Waste
Controlled Waste
and Municipal Waste

The proposed definitions for special wastes include:

- Degree of Hazard tests
- Hazardous chemicals lists
- Accutely toxic contaminants lists

These are similar to the RCRA definitions, and, if adopted, will more clearly define special wastes to OWMC.

It is quite obvious by examining the components of both the OWMC Waste Quantities study and the Canviro 500 industry survey that these quantity estimates contain wastes which are not special wastes. For example, both reports contain listings of some sewered wastes. It is questionable whether these are truly special wastes. One major volume waste stream reported in the Canviro 500 study for the Stone, Clay, Glass, Concrete Industrial Category (SIC 32) was a 1 million gallon/year stream containing silver which is pretreated prior to being sewered. A second stream from the same company of 135 gallons/year of a sludge containing silver is listed as going to recovery. We would contend that the 1 million gallon/year stream should not be listed as a sewered special waste, since it is no longer a special waste after it has been pretreated. Removal of this

legitimately sewered portion of the waste, but retaining the sludge on the Waste Quantity estimate, would reduce the proportion of total wastes attributable to SIC 32 to 3.7% from the current surprisingly high 14.9%.

Even in the estimate of total industrial special waste requiring off-site treatment and disposal, the confusion over what is or is not a special waste does exist. It is much less so than with the estimate of special waste generated. However, in the Canviro study, 14% of the waste generated or 25.4% of the waste removed from the site is reported as going to a municipal landfill site. Some of this material may, indeed, be special wastes, while other of it may be quite appropriately disposed in a municipal landfill site. With an accurate definition of special waste, this confusion would be avoided.

The major problem with the UCD waste categorization system is that it does not address degree of hazard of the waste. It does not even define the minimum concentrations of components which would cause the waste to be included in that category. For example, within UCD 143 (Aqueous Solutions with reactive anions), very dilute chloride, fluoride or sulphite solutions, may not be special wastes and could be legitimately sewered.

The adoption by Ontario of a legislated definition of special wastes would greatly reduce the confusion in estimating quantities of industrial waste generated. This would give an absolute measure against which to determine whether or not a waste stream should be included in the estimate.

In the interim, an assessment based on the proposed degree of hazard rules, as described in Appendix 4 of the Blueprint for Waste Management in Ontario [Ministry of the Environment Ontario, 1983], might be a reasonable test for whether or not a waste is a special waste.

4.2.2 LACK OF SUITABILITY OF STANDARD INDUSTRIAL CLASSIFICATION (SIC) AS A GROUPING FOR INDUSTRIAL WASTE GENERATION

There are definite deficiencies in using SIC even at the four-digit level as a method of grouping industries in terms of waste generation. As an example, SIC 2813 is a category within Chemical Manufacturing, SIC 28, covering the manufacture of industrial gases. Within this group, the manufacture of one particular gas, acetylene, results in the production of large quantities of alkaline slurries or sludges. In the Canviro study, an acetylene producer interviewed, with 12 employees, reported waste generation at 18,000 tons/year or 1,500 tons/employee. This was considered to be an outlier, but it is, indeed, a legitimate and typical waste stream. However, from the point of view of extrapolation to a total waste quantity estimate for Ontario from SIC 2813, this figure should not be simply extrapolated by employees or number of establishments in the total category. Most other industrial gas production results in very little waste. Thus, in this instance, the sensible approach would be to separate acetylene production from the rest of 2813 and extrapolate in two parts to arrive at a projected total for 2813.

This approach would require a rather comprehensive understanding of the industries and the processes used by those industries which make up each 4-digit SIC group. It would require a detailed examination of the interview records for each industrial waste quantity estimate and a decision on how that should be extrapolated. However, it is felt that this is necessary to resolve the anomalies which exist between the current waste quantities estimates, which are often based not on 4-digit but 2-digit SIC groupings. Differences between estimates by factors of up to 816 times suggest that these estimates are not reliable.

4.2.3 POOR BUSINESS STATISTICS AVAILABLE FOR THE EXTRAPOLATION OF WASTE QUANTITIES TO AN ALL ONTARIO ESTIMATE

The limitations of the Dun and Bradstreet business statistics, used to extrapolate waste quantities estimates to Ontario totals, have been noted by several reports.

The Canviro 500 study indicated that, for 189 of the 500 companies interviewed, the 4-digit SIC, as determined during the interview, was different from that reported by Dun and Bradstreet. The number of production employees resulting from the survey was only 75% of the total number of employees indicated by D and B [Canviro, 1985].

Similar deficiencies were found by the project team conducting the OWMC Waste Reduction Opportunities Study [OWMC, 1983]. They utilized the individual company waste estimates from the OWMC Waste Quantities Study [OWMC, 1982 (a)] to select companies for interview within three SIC categories, Chemicals (28), Primary Metals (33), and Fabricated Metal Parts (34). A large number of those selected turned out to be listed in the wrong 4-digit SIC category and some were even assigned to the wrong 2-digit SIC. An additional problem observed with the OWMC Waste Quantities Study estimates was that a number of companies were listed twice in the same 4-digit SIC category. For some firms, this was legitimate and meant that they had different manufacturing facilities within the Province. For others, however, these multiple listings included head offices where no manufacturing occurred. Production employees were included in these head office listings, and, therefore, industrial waste generation appropriate to that SIC category was purported to result from the head office listing.

The shortcomings of these business statistics present a double problem in estimating waste quantities, the obvious problem being of extrapolating survey or waste generation factor data to a province-wide estimate. The second problem is in designing a waste survey based on faulty

data. Of the original 500 companies selected for interview in the Canviro study, 177 had to be replaced, 125 of those replacements were caused by faulty D and B listings. The final 500 companies interviewed included twice as many small firms as had been originally targeted and a number of SIC categories were over or under represented compared to the original statistical design of the sample.

The problems with business statistics affect sample selection for waste survey, whether that sampling is designed to be random or targeted. For a targeted study, the sample is being selected to represent the industry sectors most likely to produce wastes. This will result in a greater proportion of the waste quantity estimate for that sector being represented by actual interview data. Poor business statistics will defeat the purpose of this selective approach.

To be fair to Dun and Bradstreet, we are sure that they never imagined that their data bases would be used to estimate industrial waste generation. Also, with the economic climate of the 1980's, a number of businesses are closed and others opened each year, and gathering data and updating the data base takes a finite amount of time. The erroneous assignment of SICs, particularly at the 2-digit level, is less understandable, and accuracy in this parameter must be important information for all of D and B's clients.

A check of the D and B listings with Scotts Industrial Directory of Ontario Manufacturers [Scotts, 1983], which lists product lines as well as other business statistics, gives a good cross-check with respect to the validity of the SIC assignment.

The Canviro 500 study showed interesting differences in their results between small and large companies within an individual SIC classification. Per employee generation rates which differed by factors of up to 40 were observed for small vs large companies. The intervals chosen,

viz $\leq$ 10 and > 10 production employees are not felt to be sufficient. It is understood that three additional intervals in the > 10 production employees' group will be utilized in the follow-up Canviro 1000 study. Accurate business data will again be required to both select and extrapolate in the five employment intervals chosen.

4.2.4 RELATIVELY UNTARGETED SURVEY STRUCTURE

The Canviro 500 study used a partly targeted approach to survey design. They took note from the OWMC Waste Quantities study of the four 2-digit SIC categories which were predicted to produce the most waste in Ontario, viz. SIC 28 Chemicals, SIC 33 Primary Metals, SIC 34 Fabricated Metal Parts and SIC 35 Machinery, except Electrical. In designing their survey, they divided these SIC categories into their 3-digit components to select companies for interviews. In addition, more emphasis was placed on selecting larger companies. Of the total Ontario population of companies in the SIC categories considered, 4.3% of the companies with more than 10 employees were surveyed, compared with 1.05% of the total population with less than 10 employees. This approach resulted in approximately 10% of the predicted waste quantity for Ontario being reported in a survey of 2.5% of all of the firms (viz. 500 companies out of a total population of about 20,000). With a totally random approach one might have expected to have only 2.5% of the waste recorded in the survey.

The generator survey in the OWMC Waste Quantities Study was targeted to the industry sectors which were predicted to produce the most waste by the generation factor model. Only 100 interviews were carried out, however, and it is not clear how these data were used to modify the waste quantities estimate.

New York State's hazardous waste inventory used a very targeted approach to their survey. "A total of 1,170 generators were selected from the State's estimated 4,000 potential hazardous waste generators, ...

Respondents reported a total production of more than 1.2 million tons of hazardous or potentially hazardous waste annually. It is estimated that this total represents approximately 90 percent of the hazardous waste actually generated in the State each year. ... More than 90% of this reported waste is generated by 100 firms" [Iannotti et al, 1979, i, ii].

An unreferenced estimate attributed to EPA suggests that 14,000 firms are responsible for generating 90% of the hazardous waste in the U.S.A. Reducing this number by the ratio of the populations of New York to the U.S.A., 17.6:226.6 million (1980 Census), would suggest that 1,090 companies in New York produce 90% of the waste. This is very similar to the number estimated to produce 90% of the waste in the New York State survey (1170).

Taking the U.S. Total and assuming a 10:1 ratio, U.S.A. to Canada, would indicate that 1,400 firms in Canada produce 90% of the waste. Assuming 50% of Canada's industrial activity occurs in Ontario suggests 700 Ontario firms should be responsible for 90% of the waste. A direct ratio based on Ontario population of 8 million would suggest about 500 firms producing 90% of the waste. Thus, with a well-directed targeted survey, interviewing 1,000-1,500 companies could theoretically allow one to actually inventory 90% of the waste volume and still have sufficient interviews with smaller generators to predict the total generation of waste for the Province.

Inventorying all of the major sources of wastes would greatly improve the accuracy of th overall estimate of industrial waste generated. Sufficient small companies would also be covered to indicate the types and quantities of wastes generated by these smaller sources of waste. It is recognized that the smaller firms may be those which have greater need of OWMC facilities. It would, however, be of great advantage to OWMC to have an inventory of 90% of the larger sources of waste. A market survey of these 500-600 firms would rapidly establish how much waste might require OWMC facilities. The accuracy of the estimate for the market and

quantities of waste generated by the smaller generators would be less well defined, but inaccuracies in the estimate of this 10% of the waste quantity would not greatly change the required capacity of the facility.

4.2.5 LACK OF DETAILED ANALYSIS OF WASTE QUANTITY TRENDS

The OWMC Waste Quantities Report discussed trends in waste quantities in only the most general terms, concluding that there are three factors influencing trends in waste generation, viz:

- Industrial Production
- Industrial Innovation
- Industrial Waste Management

They concluded [OWMC, 1982(a), 60] that "The net result of the interplay of these factors will be a slow decline in the total amount of waste generated in Ontario".

The Canviro 500 study did try to quantify trends in waste quantities over a 1-5 year period. The net result of a number of streams increasing and a number decreasing was an overall decrease in volume of 7.5%. With the data accessible and manipulable, trends in individual waste types from specific industries can be analyzed.

These trends analyzed by the Canviro study were those foreseen by the companies interviewed. As was discussed in Chapter 3, some of the factors which influence waste quantity trends are over and above those considered by industry. Specifically, changes in legislation and the entry into the market of OWMC may put step functions into the smooth waste quantity trend lines projected by industry.

The difficulties experienced in making the original estimate of today's waste generation, and the complexity of the issues and factors which influence future quantities, make the lack of quantitative information on waste quantity trends quite understandable.

4.3 PROPOSED APPROACH

4.3.1 INTRODUCTION

Figure 4.1 shows schematically the recommended approach to develop waste quantity and eventually a market share estimate. The approach consists of several elements, in two phases. It is recommended to first improve existing information. This would start with the refinement of the data base provided by the Canviro survey, and to add to it updated information derivable from former studies conducted for OWMC. It is further proposed that this expanded source of data be organized into process oriented groups. This information would then permit an extrapolation, on an improved basis, to obtain an estimate of total special waste in Ontario. A review of this estimate would then be conducted to identify key industrial sectors determined to be under-represented in the data base to that point. Targeted firms would be surveyed, thus firming up the estimate of total waste.

The second phase would entail the application of various factors to determine the proportion of the total waste estimate which is "special waste". Similarly, the special waste estimate would be reduced to the proportion destined for off-site management and, subsequently, further reduced to the likely market share for OWMC.

The following sections briefly review the several elements of the recommended approach.

4.3.2 REFINE DATA BASE TO INCLUDE HAZARD

A major drawback of the existing data base of industrial waste generation is, as has been detailed above, the lack of an explicit measure of their hazardousness. The hazard of the waste is the determining factor in its inclusion in regulatory restrictions on its fate, and, hence, the necessity for appropriate off-site management.

Sufficient details exist in computerized questionnaire results to enable a reasonable estimate of a waste's hazardousness to be made. Details of major waste components, and their concentrations, pH, flash point, transportation hazard, organic content, and current waste management practices should indicate the nature of the hazard posed by the waste, and if it is likely to fall under the classifications of either a hazardous or site specific waste.

Data should also be reviewed to ensure that no double accounting of wastes exists, e.g. a waste destined for treatment and the concentrated sludge from its treatment.

4.3.3 REVISE AND REFINE DATA FROM OTHER OWMC STUDIES

Approximately 100 Ontario companies were surveyed in the preparation of the OWMC Waste Quantities Study. In addition, over 200 questionnaires on waste generation and management were completed as a result of the OWMC Waste Reduction Opportunities Study. Both of these survey programmes collected detailed information on the amounts and characteristics of industrial wastes generated in Ontario. The raw data should be reviewed, and recoded and entered into the current computerized data base. These additional waste streams should also be classified according to the type of hazard they present, and their likely regulatory classification.

4.3.4 DISAGGREGATE TO PROCESS SPECIFIC GROUPS

In this work element, the various waste producing industries surveyed to form the data base should be categorized into groups employing a similar range of waste producing processes. This would include, for example, the disaggregation of the three digit SIC groups (281) of inorganic chemical producers into its four digit units, e.g. chloro-alkali producers (2812), industrial gas producers (2813), etc. The industrial gas producers should likely be again broken down into those producing acetylene and those fractionating air.

Some industrial sectors, e.g. machinery manufacturers, may be left as two digit SIC groups, given the wide use of similar processes in the manufacture of a range of metal products.

4.3.5 EXTRAPOLATE ON IMPROVED BASIS

The need has been recognized, in this and other studies, to improve the Dun and Bradstreet listing of Ontario industries by SIC number. This listing should be refined or replaced to provide a more reliable source of industry size, location and activity in Ontario.

Statistical analyses of waste generation results currently being conducted for OWMC, hopefully, will provide an indication of the most acceptable method of extrapolation (by number of firms or by number of employees).

The computer model would be revised to include the improved (and verified) extrapolation technique and a process oriented categorization of Ontario industries. Input to the model from a refined and enlarged data base should also enhance the quality of the total industrial waste estimates produced.

A further division within an industrial classification of companies by size from the ≤ 10 and > 10 production employees currently considered should also be used to further refine the estimates produced.

4.3.6 IDENTIFY LIKELY MAJOR CONTRIBUTORS

An examination of the output of the computer model of total industrial waste generation would be conducted. Salient waste producing sectors would be noted, both in terms of total quantity of waste and type (especially where separate waste treatment would be employed due to waste characteristics). Raw data responsible for these important waste streams would be reviewed to determine if the reported waste characteristics and volumes were representative of the processes entailed in the reported industrial classification. Where appropriate, further disaggregation of industrial classifications would be employed.

4.3.7 REVISE QUESTIONNAIRE

Applying lessons learned from refining and reviewing former survey results, the survey questionnaire should be revised. The revisions should include specifically a notation of the hazards and likely legal status of waste streams.

4.3.8 TARGETED SURVEY OF ADDITIONAL FIRMS

Following the identification of likely major waste contributors, a targeted survey of additional key Ontario industries would be conducted. These firms would be selected on the basis of their suspected production of significant amounts of special wastes which would be sent to OWMC.

4.3.9 SPECIAL WASTE QUANTITY ESTIMATE

The total industrial waste estimate includes many examples of low hazard (and often high volume) waste streams which would likely not be subject to the requirements of current and future regulatory initiatives on industrial waste management. Sewered wastes constitute the major component of the total industrial waste estimate which, since 90% is pretreated and hence acceptable under municipal sewer use by-laws, would not be considered special wastes to OWMC [Canviro, 1985].

The computer model of waste generation would be manipulated to exclude wastes noted as having a low hazard rating, to yield an estimate of special wastes.

4.3.10 OFF-SITE SPECIAL WASTES QUANTITY ESTIMATE

Current waste disposal practices of Ontario industries (as revealed by surveys) gives a base case for portion receiving off-site waste treatment or disposal. If, as is anticipated, regulations regarding the disposal of industrial wastes are strengthened and more rigorously enforced, the current fate of many wastes may change.

The principal parameter influencing the proportion of special wastes destined for off-site management is cost. As noted in Section 3.4.2, six factors are likely to determine cost for any particular firm, viz:

- difficulty of treatment
- size of waste stream
- availability of on-site facilities and expertise
- legislative barriers
- geographic location

The difficulty of treatment and, to at least some extent, legislative barriers are a function of the UCD waste classification and the hazard rating of the waste. The size of waste stream and availability of facilities and expertise are likely influenced by the size of the industrial firm. Hence, the number of employees may determine if these factors are pertinent to a particular firm. Geographic location through its control of transportation costs is likely a controlling factor for a limited number of companies.

The above factors are each encoded in the data base for computer model of Ontario waste generation. Thus, the model may be used to manipulate the estimate for special wastes to produce various estimates of those wastes which are candidates for off-site management.

4.3.11 MARKET SHARE ESTIMATE

The major factors affecting the market share which OWMC might expect have been detailed in Section 3.4.3 These were:

- legislation
- perceived reliability
- uniqueness of facilities
- pricing policy
- transportation policy
- marketing strategy

The first four factors are each strongly dependent upon the type (UCD classification waste) inasmuch as the type of waste is the main determinant of the management technology employed. The first two factors are also related to the hazard of the waste, e.g. particularly toxic materials may be directed to OWMC by government regulation through or by industrial firms themselves through concerns over long term liability.

Transportation policy is potentially a very important factor in establishing the market share for OWMC, inasmuch as it influences pricing policy. Location, waste type and waste volume are each possible contributing aspects to the pricing policy.

Each of the above factors may be applied to the estimate of special wastes destined for off-site management. Appropriate searches of the computerized data base would yield the market share expected for OWMC for given input parameters. In order to provide this kind of analysis, the current computer search program would have to be considerably modified to include, for example, the several interrelated factors influencing the cost of waste disposal for each firm and waste type.

The final factor affecting market share, viz. marketing strategy, is a more subjective aspect. This factor would not likely lend itself to inclusion in the waste generation model.

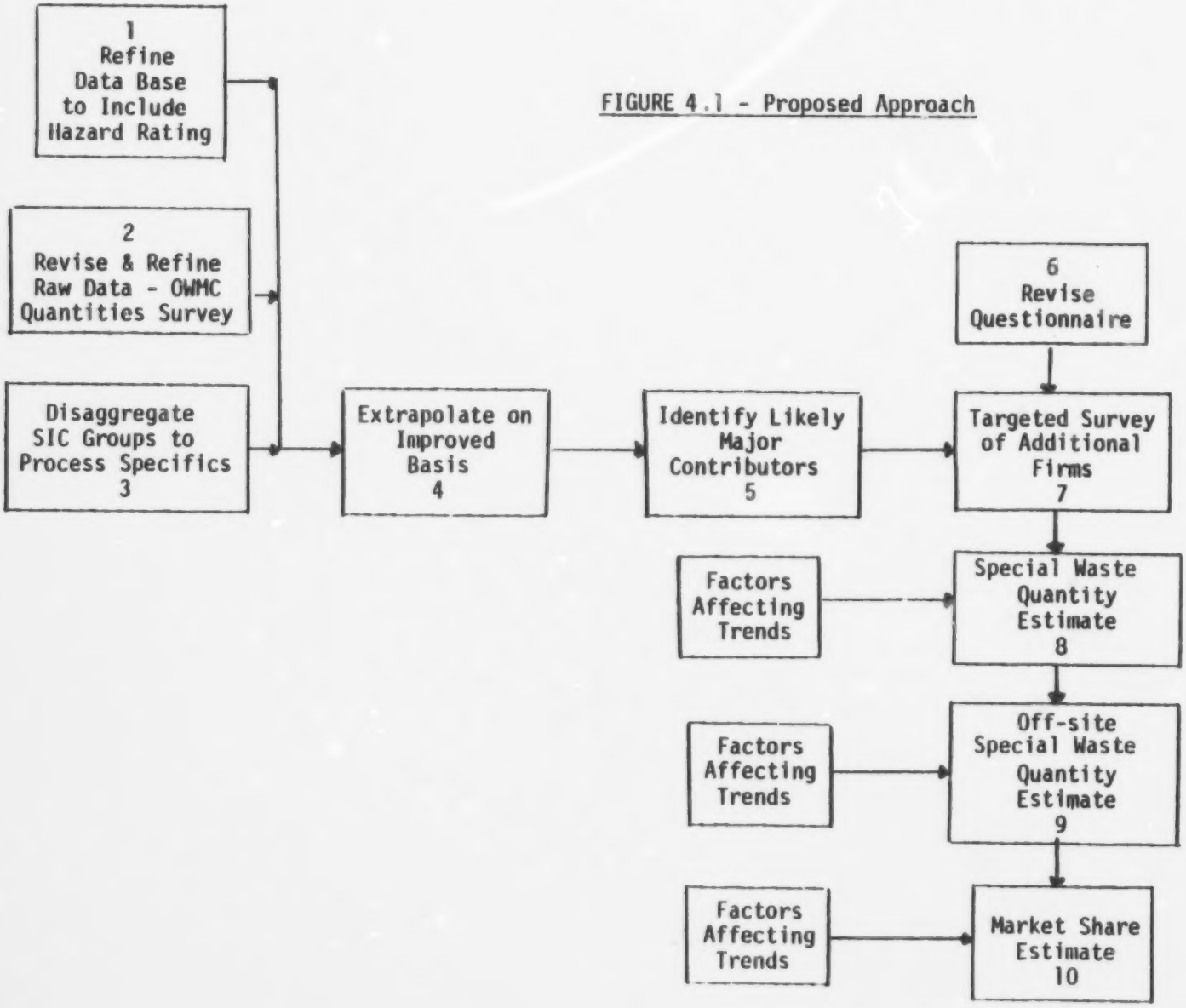


FIGURE 4.1 - Proposed Approach

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APPENDIX A

Reg. 313 Environmental Protection Act
Ontario

INSTRUCTIONS

1. **WHEN A LOAD IS PICKED UP FROM THE SOURCE:**

   (a) **THE CARRIER** shall complete **SECTION C**, and an authorized person at the **SOURCE** shall complete **SECTION A**. The White and Green Copies are then left with the **SOURCE**.

   (b) **THE SOURCE** shall forward the White copy to the Ministry of the Environment at the address shown below, and retain the Green copy for one year.

---

2. **WHEN A LOAD IS DELIVERED TO THE RECEIVER:**

   (a) **THE RECEIVER** shall complete **SECTION B**. The Yellow and Blue copies are left with the **RECEIVER**. **THE CARRIER** may retain the Pink copy for his records.

   (b) **THE RECEIVER** shall forward the Yellow copy to the Ministry of the Environment at the address shown below, and retain the Blue copy for one year.

---

3. **WHEN A LOAD IS DELIVERED TO A SEWAGE WORKS:**

   THE CARRIER shall complete **SECTION B** and forward the Yellow copy to the Ministry of the Environment at the address shown below. **THE CARRIER** shall retain the Blue copy for one year.

---

4. **FORWARD THE MINISTRY'S COPIES FORTHWITH** (within three working days),

   TO: The Ontario Ministry of the Environment
   Waste Management Branch, Waybill Processing Centre
   136 St. Clair Ave., W.
   2nd Floor
   Toronto, Ontario
   M4V 1P5

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5. **** PENALTY ****

   The maximum penalty for conviction on failing to comply with the regulation is $2,000. (Environmental Protection Act, 1971, Section 47)

Ministry of the Environment
Ontario

Transfers of Liquid Industrial Waste

Ontario Regulation 313

Important: See Instructions on Reverse

SOURCE (Complete Section A Only. Please Print)

A

Company Name

Waste Source Location — City/Town

Waste Description: Check One.

101 ☐ Acids	201 ☐ Oily Water	301 ☐ Pigments, Paint, Printing & Adhesives
102 ☐ Alkalis	202 ☐ Waste Oils	302 ☐ Pesticides
103 ☐ Metal Finishing Wastes	203 ☐ Organic Solvents	303 ☐ Detergents, Cleaners & Soaps
104 ☐ Cyanides	204 ☐ Chlorinated Solvents	304 ☐ Pharmaceutical & Cosmetics
105 ☐ Chemical Fertilizer Wastes	205 ☐ Plastic Resins	401 ☐ Plant & Animal Wastes
106 ☐ Phosphates	206 ☐ Amines	402 ☐ Inert Sludges
	207 ☐ Glycols	
	208 ☐ Phenols	
	209 ☐ PCB's	

199 ☐ Other Inorganic (Specify) — 299 ☐ Other (Specify)

Quantity ☐ Gallons ☐ Litres

Time Released — Day — Month — Year — Signature of Authorized Person

RECEIVER (Complete Section B Only. Please Print)

B

Company Name — MOE Certificate of Approval No. A

Site Location — City/Town

Final Disposal By: ☐ Secure L… ☐ Incinerator ☐ Other (Specify Method)

OR ☐ Transfer To: Name ____ Address ____

Time Received — Day — Month — Year — Signature of Authorized Person

CARRIER (Complete Section C Only. Please Print)

C

Company Name — Waste Mgmt System Number A

Address — Number — Street — City/Town

Vehicle License Plate Number — Signature of Driver

MOE 1270 (10/82)

MINISTRY'S COPY

SAMPLE ONLY

12708

A-1

REGULATION 313

under the Environmental Protection Act

TRANSFERS OF LIQUID INDUSTRIAL WASTE

1.—(1) In this Regulation,

(a) "hauler of waste" means a person who transports liquid industrial waste;

(b) "liquid industrial waste" means liquid waste that is a product of,

(i) an enterprise or activity involving industrial, manufacturing or commercial processes or operations,

(ii) research or an experimental enterprise or activity, or

(iii) an enterprise or activity to which subclause (i) would apply if the enterprise or activity were carried on for profit,

but does not include,

(iv) waste that is a product of a sewage system subject to the provisions of Part VII of the Act or a sewage works subject to the *Ontario Water Resources Act* or waste that is removed from a holding tank to which regulations made under clause 126 (3) (a) or (b) of the Act apply,

(v) waste discharged by its producer at the site where the waste is produced into municipal sanitary sewage works in accordance with applicable by-laws or into a sewage system, as defined in Part VII of the Act, that is being operated in accordance with the Act,

(vi) waste disposed of at a waste disposal site as defined in Part V of the Act, operated by the producer of the waste and located on the site where the waste is produced, or

(vii) waste that is wholly used or recycled

(2) Liquid industrial waste is designated as a waste in addition to those wastes specified in clause 24 (d) of the Act. O. Reg. 926/76, s. 1.

2. Those facilities, equipment and operations of a producer of liquid industrial waste that are involved in the collection, handling or storage of liquid industrial waste are classified as a Class 1 waste management system. O. Reg. 926/76, s. 2.

3. Those facilities, equipment and operations of a hauler of waste that are involved in transporting liquid industrial waste are classified as a Class 2 waste management system. O. Reg. 926/76, s. 3.

4.—(1) No operator of a Class 1 waste management system shall permit liquid industrial waste to pass from his control except by transfer of the liquid industrial waste to a Class 2 waste management system for which a certificate of approval or a provisional certificate of approval has been issued.

(2) Where liquid industrial waste is transferred to a Class 2 waste management system from a Class 1 waste management system,

(a) the operator of the Class 2 waste management system shall provide to the operator of the Class 1 waste management system a numbered form obtained from the Ministry for the purpose, upon which form he has recorded his name and address and the registration number of the vehicle used; and

(b) the operator of the Class 1 waste management system shall obtain from the operator of the Class 2 waste management system the form referred to in clause (a) and shall,

(i) record on the form,

(A) the name and address of the producer of the liquid industrial waste,

(B) the description and amount of the liquid industrial waste being transferred, and

(C) the date, time and place of the transfer,

(ii) sign the form, and

(iii) forward the completed form forthwith to the Ministry, retaining one copy thereof for a period of one year. O. Reg. 926/76, s. 4.

5.—(1) No operator of a Class 2 waste management system shall permit liquid industrial waste to pass from his control except by transfer of the liquid industrial waste,

(a) to a waste management system or a waste disposal site for which a certificate of approval or a provisional certificate of approval has been issued, or

(b) to a sewage works under the *Ontario Water Resources Act* for which an approval under that Act has been issued and with the approval of the owner of such sewage works.

(2) Where liquid industrial waste is transferred from a Class 2 waste management system,

(a) the operator of the Class 2 waste management system shall,

(i) on a numbered form obtained from the Ministry for the purpose, record,

(A) his name and address,

(B) the registration number of the vehicle used,

(C) a list of the numbers of all the forms provided under clause 4 (2) (a) in respect of the liquid industrial waste being transferred, and

(D) if any of the liquid industrial waste being transferred was received from a Class 2 waste management system, a list of the numbers of all forms with which he was provided in respect of the receipt of the liquid industrial waste being transferred, and

(ii) if the transfer is to a sewage works under the *Ontario Water Resources Act*,

(A) record on the same form,

1. the location of the sewage works,

2. the description and amount of the liquid industrial waste being transferred, and

3. the date, time and place of the transfer, and

(B) sign the form and forward the completed form forthwith to the Ministry, retaining one copy thereof for a period of one year, or

(iii) if the transfer is to a waste management system or waste disposal site, provide the operator thereof with the form prepared as prescribed in subclause (a) (ii),

(b) the operator of a waste management system or waste disposal site to which the liquid industrial waste is transferred shall obtain the form prepared as prescribed in subclause (a) (ii) and shall,

(i) record on the form,

(A) the location and the name of the operator of the waste management system or waste disposal site,

(B) the number of the certificate of approval or provisional certificate of approval for the waste management system or waste disposal site,

(C) the description and amount of the liquid industrial waste being transferred,

(D) the date, time and place of the transfer of the liquid industrial waste, and

(E) the date and method of disposal, the method of treatment or processing, or the destination of the liquid industrial waste, whichever is applicable,

(ii) sign the form, and

(iii) forward the completed form forthwith to the Ministry, retaining one copy thereof for a period of one year. O. Reg. 926/76, s. 5.

6.—(1) A Class 1 waste management system is exempt from section 27 of the Act in respect of the collection, handling and temporary storage of liquid industrial waste at the site where it is produced.

(2) The exemption in subsection (1) does not apply where the liquid industrial waste is a product of a waste management system or waste disposal site. O. Reg. 926/76, s. 6.

APPENDIX B

UCD Waste Classification System

and

MOE Waste Classification System

(i) UCD Waste Classifications

CONSTITUENTS OF SPECIAL WASTE

UCD WASTE	DESCRIPTION	TYPICAL WASTES
11 ACIDIC SOLUTIONS		
111	Acidic Solution with Heavy Metals	Pickle Liquor Rinse Water
112	Acidic Solution with Other Metals and Non-Metals	Demineralizer Regenerent
113	Other Acidic Solutions	Boiler Stack Scrubber Water with Dilute Carbonic Acid (H_2CO_3)
12 ALKALINE SOLUTIONS		
121	Alkaline Solution with Heavy Metals	Rinse Waters from Surface Cleaning of Metals
122	Alakaline Solution with Other Metals	Demineralizer regenerent
123	Other Alkaline Solutions	Cleanup Water from Lime or Cement Kiln
13 METAL FINISHING SOLUTIONS		
131	Metal Finishing Solutions, Acid	Ammonia Based, Containing Copper, Tin, Lead or Cadmium
132	Metal Finishing Solutions, Alkaline	Contains Strong Complexing Agent and Copper, Tin, Lead and/or Cadmium
133	Spend Pickle Liquor from Ferrous and Non Ferrous Metals	Strong Acids with Iron, Fluoride, Hydrochloric Acid (HCl), Sulfuric Acid (H_2SO_4), Nitric Acid (HNO_3)

CONSTITUENTS OF SPECIAL WASTE

UCD WASTE	DESCRIPTION	TYPICAL WASTES
14 OTHER AQUEOUS SOLUTIONS		
141	Aqueous Solutions with Heavy Metals	Cleaning Solutions from Tanks, Trucks, or Railroad Tankers
142	Aqueous Solutions with Other Metals	Rinse Water from Heat Treating Salt Baths, Contain Barium, Aluminum
143	Aqueous Solutions with Reactive Anions	Bleaching Solutions Containing Sulfite, Chlorite, Fluoride, Bromate
145	Brine	Salt Solutions After Neutralization or Chlor/Alkali Production
146	Solutions Containing Cyanide	Plating Baths
147	Solutions Containing Sulfides	Plating Baths
15 INORGANIC SOLIDS		
151	Inorganic Solids	Foundry Sand with Phenolics
152	Inorganic Solid Chemicals	Aged or Off Spec. Chemicals Including Lime, Caustic Soda and Partial Containers of Laboratory Size
16 OTHER INORGANIC WASTES		
165	Spent Catalyst	Maybe Carbon or Metal
167	Other Inorganic Waste	Ash and Construction Residue

CONSTITUENTS OF SPECIAL WASTE

UCD WASTE	DESCRIPTION	TYPICAL WASTES
21 SPENT SOLVENTS		
211	Halogenated Solvents with Heavy Metals	Methylene Chloride, 1, 1, 1, Trichloroethylene Used for Metal Cleaning
212	Halogenated Solvents with Other Metals	Surface Cleaning and Degreasing Solvents
213	Other Halogenated Solvents	Freon with Other Solvents Used in Chemical Processing
214	Non-Halogenated Solvents with Heavy Metals	Toluene, Benzene, Xylene Contaminated with Catalysts
215	Non-Halogenated Solvents with Other Metals	Acetone, Methylisobutylketone (MIBK) used in Paint and Varnish Formulation
216	Other Non-Halogenated Solvents	Methylethylketone and Other Solvents Contaminated with Dirt
217	Unspecified Solvents	Alcohols and Mixtures of Solvents
22 OTHER ORGANIC LIQUIDS		
221	Organic Liquids with Metals and Halogens	Dyes
222	Organic Liquids with Halogens Only	Chloroform, Carbon Tetrachloride
223	Organic Liquids with Metals Only	Nickelcarbonyl, Methyl Mercury
224	Other Organic Liquids	Creosote and Other Poly Aromatic Hydrocarbons
225	Aqueous Solution with Non-Halogenated Residues Less Than 10%	Laboratory Mixtures
226	Aqueous Solutions with Halogenated Residues Less Than 10%	Waste or Rinse Waters After Degreasing

CONSTITUENTS OF SPECIAL WASTE

UCD WASTE	DESCRIPTION	TYPICAL WASTES
227	Aqueous Solution with Non-Halogenated Organic Residue Greater Than 10%	Laboratory Mixtures
228	Aqueous Solution with Halogenated Organic Residue Greater Than 10%	Wash or Rinse Waters after Degreasing
24 - 25 OTHER ORGANIC WASTES		
241	Pesticides and Wastes	Partial Containers, Tank Washings, Off Spec. Product, etc.
242	PCB Oils and High Strength (over 500 ppm) Liquids	From Transformers and Capacitors
243	Pharmaceuticals and Wastes	Off-Spec. Drugs, Cleanup Waters, etc. Includes Items such as Vitamins
244	Photochemical Waste	Most Solutions Non-Toxic Except those with Silver
245	Off-Spec or Aged Organics	Can Include Solids or Liquids. Generally in Containers
247	Halogenated Still Bottoms	Spent Solvent or Waste Oil Recovery
248	Non-Halogenated Still Bottoms	Solvent Recovery Operations
251	Tannery Wastes - Liquid	Solutions with Hexavalent Chromium.
252	Solid or Sludge Tannery Wastes	Leather Shavings with Chrome,
254	Adhesives or Glue	Waste Glues Mostly Aqueous. Some with Phenols

CONSTITUENTS OF SPECIAL WASTE

UCD WASTE	DESCRIPTION	TYPICAL WASTES
257	Phenolic Wastes	Phenolic Oil. Toluene Diisocyanide Residue
258	Waste Tar and Residues	
26 POLYMERIC MATERIAL WASTES		
261	Polymeric Resin	Polyester, Urethane, Etc.
262	Latex Wastes	Cleanup Water, Paint, Latex and Acrylic Resins
263	Other Polymeric Wastes	Kettle Bottoms, Thermoplastic Resins,
264	Thermoset Wastes	Urea-Formaldehyde and Thermoset Wastes
28 OILY WASTES		
281	Waste Oil and Mixed Oil	Used Automotive Oil, Hydraulic Oil, Cutting Oil - May Contain Solvents or Metals
282	Oily Tank Bottoms	Crude Oil or Sludge from Storage
283	Oily Mud, Sediment and Water	Crude Oil Tanker Cleaning
284	Oily Acidic Solids	Solids from Emulsion Breaking and Re-Refining
285	Oily Alkaline Solids	Refining Solids
286	Oil/Water Separator Sludge	Oil Cooled Heavy Inorganics
288	Oily Wastes with Heavy Metal Contaminants	Steel Rolling Mill Sludges and Mill Scale
289	Oily Wastes with Water	Emulsions, Cleanup Water from Garages, Cooling Waters

CONSTITUENTS OF SPECIAL WASTE

UCD WASTE	DESCRIPTION	TYPICAL WASTES
41 RELATIVELY INERT SLUDGES		
416	Ink Sludge	Sludge Could Contain Solvents, and Lead, Cesium, Chromium
417	Alum and Gypsum Sludges	Waste Water Phosphate. Removal Sludge
43 METAL SLUDGES		
431	Heavy Metal Sludge	Similar to that in 111, 113, 121, 123, 132, 133, 141,
433	Other Metal Sludges	Ferric Chloride, Aluminum Oxide, etc.
44 - 45 OTHER SLUDGES		
441	Lime Sludges	From Treatment of Acids and Similar to 431 and Derived from 111, 113, 121, 123, 131, 132, 133, 141
443	Sulfur Sludge	Desulfurization of Flue Gas Non-reactive but Very Low Bearing Strength
444	Cyanide Bearing Sludge	Pot Liners from Aluminum Reduction and Scrubber Sludge from Blast Furnace
445	Plating or Metal Finishing Sludge	Derived Mostly from 131, 132, 133
446	Degreasing Sludge	Grease and Oily Soil Containing Trichloroethane (TCE)
447	Tetraethyl Lead Sludge	Tank Bottoms
454	Paint Sludge	Drum Bottoms, Spills, Cleanup, etc.
455	Paint Sludge Without Heavy Metals	Mostly Latex

CONSTITUENTS OF SPECIAL WASTE

UCD WASTE	DESCRIPTION	TYPICAL WASTES
50 - 53 MISCELLANEOUS		
509	Gas Cylinders or Containers	Oxygen Cylinders - Empty
512	Spill Cleanup	Oil/Soil Mixture
513	Laboratory Waste Chemicals	Partially Full Small Containers
518	Dust Collector Wastes	Dry Lime from Dust Control Baghouse
521	Spent Cartridge Filters	Air Cleaning Filters on Ventilation System
523	Tank Bottom Sediments	
528 *	Pathogenic Wastes	Used Bandages, Dressings
531	Contaminated Rags	Cleanup Materials
532	Equipment and/or Containers Contaminated with Pesticides	Empty Pesticide Cans

* Explosive Wastes

UCD WASTE CLASSIFICATIONS EXCLUDED FROM SPECIAL WASTE

(Deemed to be outside OWMC Mandate and hence quantities not calculated)

UCD Number	Waste Category	Description
144	Other aqueous solution	Aqueous solutions (14) other than 141, 142, 143, 145, 146, or 147.
161	Asbestos-containing wastes	
162	Aluminum or tin wastes.	
231	Organic solids with halogens	Polyvinyl.
232	Organic solids without halogens	Polyethylene
253	Detergent and soap.	Liquid, aqueous waste solutions and organic solids from production or cleaning operations.
255	Unspecified organic wastes.	Organics not listed in other categories.
271	Sewage sludge	
272	Other Biological Wastes	Including animal fat, molasses wastes and dough.
412	Filter cake	Contaminated filter material, e.g., diatomaceous earth.
413	Gas scrubber sludge.	From gas cleaning operations.
442	Phosphate sludge.	
453	Paper sludge/pulp.	Paper and cardboard manufacture source.
456	Other waste treatment sludge.	Sludges not otherwise identified due to lack of composition data.
457	Sludges with organic residues.	Includes some halogenated components.
510	Flue-gas scrubber liquid.	
511	Rinse water and waste water.	Contains small units of oil, solvent, metals and/or mud; also bilge water.
514	Contaminated oil and sand.	

UCD WASTE CLASSIFICATIONS EXCLUDED FROM SPECIAL WASTE

(Deemed to be outside OWMC Mandate and hence quantities not calculated)

UCD Number	Waste Category	Description
515	Drilling mud.	
519	Fly ash and retort ash.	Combustion-generated particulates mineral matter plus some carbon
524	Chemical toilet wastes.	
525	Metal dust and machining wastes	Primarily ferrous and aluminum-based alloys.
526	Cannery wastes.	
527	Mud/sediment and water.	
530	Contaminated pallets.	
533	Contaminated equipment and containers	Contaminants not stated.
535	Totally unspecified wastes	Used only for California manifest purposes.

(ii) MOE Waste Classification System

MINISTRY OF THE ENVIRONMENT ONTARIO

WASTE CLASSIFICATION SYSTEM

101	Acids
102	Alkalis
103	Metal Finishing Wastes
104	Cynaides
105	Chemical Fertilizer Wastes
106	Phosphates
190	Other Inorganics
201	Oily Water
202	Waste Oil
203	Organic Solvents
204	Chlorinated Solvents
205	Plastics/Resins
206	Amines
207	Glycols
208	Phenols
209	PCBs
290	Other Organics
301	Pigments, Paint, Printing and Adhesives
302	Pesticides
303	Detergents, Cleaners and Soaps
304	Pharmaceuticals and Cosmetics
401	Plant and Animal Wastes
402	Inert Sludges

APPENDIX C

Ministry of the Environment Ontario
Waybill Data 1982 and 1983

ONTARIO MINISTRY OF THE ENVIRONMENT MAYBILL - 1982

	101 ACIDS	102 ALKALIS	103 METAL FINISH	104 CYANIDES	105 FERTIL	106 PHOSPH	190 OTHER INORGANIC	201 OILY WATER	202 WASTE OIL	203 ORG. SOLV.	204 CHLOR. SOLV.	205 PLASTIC RESINS	206 AMINES	207 GLYCOLS	208 PHENOLS	209 PCB'S	290 OTHER ORGANIC
TRICR. LANDFILL	318,300	236,900	233,800	3,500	0	22,000	1,198,600	243,800	82,800	30,100	0	113,100	12,900	3,700	11,300	0	307,800
MUNICIPAL LANDFILLS	300	2,600	0	0	0	22,700	82,900	58,200	0	0	0	351,500	0	0	0	0	2,200
PRIVATE LANDFILL & FARM	0	253,300	0	0	0	0	320,500	1,308,800	6,000	300	0	185,500	0	0	0	0	0
INCINERATION	188,400	83,900	71,500	50	1,200	88,800	1,338,400	3,868,300	382,300	2,470,800	0	261,000	588,700	308,800	162,200	0	1,287,100
POLLUTION CONTROL PLANTS	0	189,200	0	0	0	125,800	1,831,700	138,500	0	0	0	0	0	0	0	0	880,000
OUT OF PROVINCE	1,303,300	808,400	435,100	28,900	3,500	4,200	841,700	807,800	821,800	1,253,200	23,300	5,000	0	5,000	0	18,700	41,700
RECLAIM/REUSE	12,500	13,700	0	0	0	0	18,800	4,848,200	88,400	11,000	800	233,800	0	0	0	0	888,100
MISCELLANEOUS	1,314,800	438,300	88,500	800	0	0	18,200	82,400	34,000	32,800	12,700	0	0	8,000	0	1,300	70,800
TRANSFER STATIONS	211,500	348,100	153,800	11,800	0	74,200	773,500	1,088,100	215,700	2,248,500	188,500	227,400	18,000	18,300	238,400	800	434,800
TOTAL	3,357,800	2,478,400	983,500	44,850	4,700	315,800	8,635,300	12,832,800	1,842,100	8,048,500	285,300	1,357,100	630,600	344,800	412,800	18,800	3,810,800
METRIC TONNES	15,283	11,229	4,380	204	21	1,435	38,160	57,422	7,484	27,484	933	6,168	2,886	1,568	1,877	85	17,321

ONTARIO MINISTRY OF THE ENVIRONMENT HAYBILL - 1982

301 PIGM PAINT	302 PESTIC	303 DETERG CLEANERS	304 PHARM & COSM	401 PLANT ANIMAL	402 INERT SLUDGES	TOTAL	PERCENT
89,300	0	11,100	0	8,300	1,638,800	4,577,800	9.1%
83,800	0	0	28,500	308,500	1,424,100	2,355,100	4.7%
480,800	0	0	0	1,429,800	288,400	4,252,000	8.5%
376,400	12,000	64,400	1,300	2,800	124,700	11,825,350	23.5%
9,500	0	114,300	0	888,700	75,800	4,233,100	8.4%
180,200	3,800	87,100	0	0	10,200	6,888,100	13.7%
114,500	0	0	10,500	85,300	243,600	6,788,000	13.5%
7,100	100	44,000	0	0	8,000	2,123,200	4.2%
755,800	8,700	47,800	27,700	35,500	144,800	7,232,500	14.4%
2,081,000	25,700	388,700	68,000	2,870,000	3,988,000	50,283,250	
8,505	117	1,876	300	13,045	18,036	228,580	

ONTARIO MINISTRY OF THE ENVIRONMENT HAYBILL - 1983

1983 ANALYSIS

	101 ACIDS	102 ALKALIS	103 METAL FINISH	104 CYANIDES	105 FERTIL	106 PHOSPH	199 OTHER INORGANIC	201 OILY WATER	202 WASTE OIL	203 ORG. SOLV.	204 CHLOR. SOLV.	205 PLASTIC RESINS	206 AMINES	207 GLYCOLS	208 PHENOLS	209 PCB'S	299 OTHER ORGANIC
TRICIL LANDFILL	244,423	289,153	40,560				540,138	82,784	134,277	-		9,575					382,501
MUNICIPAL LANDFILLS						51,881		15,015		1,300							
PRIVATE LANDFILL & FARM		713,300					50,500	1,235,730	3,000			578,880					1,000
INCINERATION	73,518	263,260	88,629	48,800			1,048,198	4,038,515	358,122	2,208,304		238,117	884,795	141,084	240,805		1,785,802
POLLUTION CONTROL PLANTS	38,845	8,928			1,000	78,150	11,348,220	1,885,410	1,250					22,458	8,000		8,570,705
OUT OF PROVINCE	2,125,235	281,658	290,011	12,162		25,830	677,588	1,038,883	1,088,424	1,087,758	18,548	21,333		1,885		40,155	24,958
RECLAIM/REUSE	1,583,358	842,743		2,818			18,124	7,188,771	385,885	448,078	42,443	188,748					748,712
MISCELLANEOUS	888	8,125					14,881	88,115	27,885	1,848						1,882	2,858
TRANSFER STATIONS	448,418	227,845	285,382	18,831		88,888	81,988	1,881,884	188,388	2,851,143	143,878	273,885	1,857	88,812	171,484	3,174	385,158
TOTAL	4,482,387	2,814,818	884,782	88,283	1,888	218,838	13,788,828	17,174,237	2,145,343	8,888,422	282,887	1,318,558	885,852	225,228	421,388	45,211	8,888,578
METRIC TONNES	28,428	11,888	2,748	385	5	1,888	82,878	78,885	9,752	38,452	918	5,884	3,183	1,824	1,815	288	44,848

ONTARIO MINISTRY OF THE ENVIRONMENT MAYBILL - 1983

301 PIGM PAINT	302 PESTIC	303 DETERG CLEANERS	304 PHARM & COSM	401 PLANT ANIMAL	402 INERT SLUDGES	TOTAL	PERCENT
80,220		7,000	2,430		983,232	2,760,893	3.8%
81,545		450	29,395		2,825,750	2,805,318	3.8%
120,800				240,500	1,188,120	4,138,830	5.7%
703,337	12,000	83,945	2,045	3,500	288,707	12,254,882	17.0%
11,500		102,200	8,000	883,887	124,800	20,883,182	28.0%
732,284	180	55,817	7,920		88,148	7,574,181	10.5%
177,758		5,580	5,925	428,239	1,284,981	13,318,838	18.5%
3,800						128,588	0.2%
927,322	34,682	71,381	27,029	22,688	111,884	8,238,547	11.4%
2,838,488	48,872	328,873	82,744	1,587,804	8,851,512	72,138,115	
12,902	213	1,488	378	7,128	30,234	327,884	

ONTARIO MINISTRY OF THE ENVIRONMENT MAYBILL - 1983

1983 ANALYSIS

	TOTAL INORGANIC	PERCENT	TOTAL ORGANIC	PERCENT	TOTAL OTHER	PERCENT	GRAND TOTAL	PERCENT TOTAL
TRICIL LANDFILL	5,085	40.0%	2,814	22.2%	4,789	37.8%	12,668	3.9%
MUNICIPAL LANDFILLS	236	1.8%	74	0.6%	12,442	97.6%	12,751	3.9%
PRIVATE LANDFILL & FARM	3,472	18.5%	8,257	43.9%	7,074	37.6%	18,803	5.7%
INCINERATION	6,812	12.2%	44,022	79.0%	4,871	8.7%	55,704	17.0%
POLLUTION CONTROL PLANTS	52,155	54.9%	37,722	39.7%	5,046	5.3%	94,923	29.0%
OUT OF PROVINCE	15,420	44.8%	14,988	43.5%	4,020	11.7%	34,428	10.5%
RECLAIM/REUSE	11,038	18.2%	40,882	67.5%	8,648	14.3%	60,545	18.5%
MISCELLANEOUS	104	17.6%	468	79.4%	18	3.0%	588	0.2%
TRANSFER STATIONS	4,800	12.8%	27,220	72.7%	5,432	14.5%	37,452	11.4%
TOTAL	99,099		176,427		52,338		327,884	

METRIC TONNES

APPENDIX D

Detailed Review of Pertinent Reports on Waste Quantities

APPENDIX D
DETAILED REVIEW OF PERTINENT REPORTS ON WASTE QUANTITIES

D.1 INTRODUCTION TO THE REVIEW

Sixteen reports are reviewed in this appendix, all of which have either estimated industrial waste quantities in Ontario or have been used as data sources by other studies which have estimated quantities for Ontario. The format chosen for these reviews, in the following 16 subsections, is to pose and answer a series of six questions and to follow that with a commentary section. The six questions which are addressed in each review are as follows:

- What is the relevance of this study to OWMC?
- What waste quantity is this study estimating?
- What waste categories does this study use?
- What method did the study use to generate waste quantity data?
- How did the study extrapolate waste quantity estimates to Ontario data?
- How useful is this report to future waste quantity estimates?

While this approach to the reviewing process has a negative effect on its literary style, it ensures that the important questions are addressed and results in consistent organization of each of the reviews. This will make it easier for the reader to make his own comparisons between the different studies. The commentary section picks up other important information from the various reports.

D.2 OWMC WASTE QUANTITIES STUDY, AUGUST 1982

[OWMC, 1982 [a]]

D.2.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

The waste quantities study was conducted by The Proctor and Redfern Group for the Ontario Waste Management Corporation, and completed in August, 1982. The main objectives of that study were "to determine the types, quantities and sources of hazardous liquid industrial and hazardous waste generated in Ontario, to identify facilities now recovering, treating and disposing of such wastes generated in Ontario (and) to develop a computerized data base that can be updated and used as a monitoring tool".

The results of the study were intended to aid OWMC in "identifying potential locations for recovery, treatment and disposal facilities, designing treatment facilities, and determining the types and quantities of waste" that would be received by such facilities.

D.2.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

The estimated rate of waste generation reported in the OWMC Waste Quantities Study was directed to reflect the "total waste generated by industry in Ontario", where waste referred to hazardous liquid industrial waste and hazardous waste.

It was specifically noted in the study that the estimate included waste:

- managed at existing off-site or on-site treatment facilities
- reused or recycled at the facility producing the waste or others
- sewered
- stored
- treated or disposed outside of Ontario

Wastes "applicable" to the waste quantities study were those "industrial, non-radioactive wastes requiring treatment and disposal by special facilities, i.e. by facilities other than sewage treatment plants and municipal waste incinerators and landfills". "Applicable" wastes were defined as specifically excluding municipal solid wastes and sewage, non-hazardous industrial wastes, and industrial wastes which remain at the site of generation (tailings, dredgings, drilling muds, etc.).

D.2.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

The Waste Quantities Study employed the waste classification system developed by the University of California at Davis (UCD). The basic UCD system includes 106 waste categories. 27 of these categories were determined to be outside the OWMC mandate, i.e. not applicable, and hence were not included in the calculation of waste quantities.

D.2.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

The method used in the Waste Quantities Study for OWMC was based upon the use of "waste generation factors, i.e. waste per employee or plant". Waste generation factors were collected from five sources developed for other jurisdictions (the U.S.A. - Mitre Corp Study, State of New York, State of Illinois, State of Minnesota and Northern and Western Canada). In addition, approximately 100 key Ontario industries were surveyed (by site visit) to provide new generation rates and/or to verify waste generation predictions.

Generation factors derived from the hazardous waste studies for other jurisdictions were not obtained directly from the raw data of questionnaires or site surveys. The techniques used to extract waste generation factors from these other studies are noted below.

The Mitre Report [Mitre, 1972] on hazardous waste generation employed estimates on a two digit SIC basis of total hazardous waste. This would have been of little value in the Waste Quantities Study and apparently was not included in the calculation model.

The Illinois Waste Survey [GGA Corp, 1980] reported waste generation on 252 summary sheets. Each sheet noted the range of generation rates for similar wastes reported by different SIC groups. These summary sheets represented approximately 10 SIC groups on average, and ranged from one to 80 SIC groups. The Waste Quantities Study employed the Illinois study results as maximum and minimum generation rates for each of 252 specific waste types on a plant and employee basis for a number (on average 20) SIC groups.

The New York waste inventory [Iannotti et al, 1979] reported hazardous waste generation by 2, 3, and 4 digit SIC groups on a total of 31 summary tables. Generation factors were derived from these tables, using the employment values for those industries surveyed and which reported waste (1,170 firms were surveyed and 710 reported at least one waste stream).

The New York inventory was highly selective in its choice of industries to survey (choosing only those expected to generate significant quantities of waste). Their inventory did not extrapolate their survey results.

The Waste Quantities Study derived generation factors on a per plant and per employee basis from the New York inventory.

The hazardous waste survey conducted for Northern and Western Canada [Reid Crowther, 1980] used mostly generation factors derived from the New York industrial hazardous waste inventory. These generation factors were derived from the New York study in much the same manner as was

performed in the Waste Quantities Study. This study did not, however, include productivity differences between Canada and the U.S.A.

The estimate of hazardous waste generation for Minnesota [Barr Engineering et al, 1979] was developed through the extrapolation of data obtained from earlier studies in that State. The extrapolation technique employed the number of production employees in two-digit SIC groups. Raw data on generation factors was not presented. Hence, it is not apparent how data from the report for Minnesota referenced in the Waste Quantities Study could have been employed for the Ontario hazardous waste estimate.

D.2.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

The Waste Quantities Study employed a computer model to develop estimates for hazardous wastes in Ontario. The model used as inputs industry and waste type specific waste generation factors, on an employee or plant basis, derived from waste survey results reported in other jurisdictions and on a limited number (100) of surveys conducted in Ontario, and a listing of the employees' location and SIC code for Ontario industries. Differences in productivity between U.S. and Canadian industries were used to adjust waste generation factors derived from the U.S. studies.

The computer model developed for the study determined the waste generated on a per plant basis - employing waste generation factors specific to each industry group (as determined by the Standard Industrial Classification of the plant). An algorithm was developed to average the generation factors where more than one was available (from the different sources employed) for specific UCD/SIC combinations. The model also eliminated outliers from the generation factors employed.

D.2.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

Since this study was done directly for OWMC to estimate the quantity of industrial special waste generated in Ontario, this report must continue to be considered in any future estimates of waste quantities generated in the province.

The lack of detailed information in the report, and the lack of access to the programs and data base used to generate the estimates, make its utility rather limited in terms of OWMC estimating potential market share.

Since 100 generator interviews were conducted during this study, it would be worthwhile to consider entering these data into the current data base being developed by Canviro (see Section D.5). Not all of the data being generated by Canviro is available from the OWMC Waste Quantities study interviews, but the major quantity, SIC, geographic, fate of waste, accuracy and recycle potential information was assessed. Not all waste constituents would be available. These interviews would increase the Canviro data base to 600 and eventually to 1,100.

Other useful information included in the report was the analysis of productivity differentials between the U.S.A. and Canada. If reliable generation factor data are developed in the U.S.A., this productivity analysis will be useful to modify such data to be more applicable to Ontario.

D.2.7 COMMENTARY

As stated above, the lack of detailed information available on the methodology used to derive the generation factors used in this study destruct from its usefulness. The reports utilized to develop specific UCD/SIC generation factors on a per employee or per plant basis all took

very different approaches to their own waste generation estimates. It is not clear from the Waste Quantities Report how these differences were accounted for in the computer program used to generate Ontario-wide waste quantity data.

It is strongly suspected that, because the Northern and Western Canada Study and the New York Study were the sources of very similar generation factors, the averaging algorithm of the computer model would result in the New York inventory having a dominant influence on the estimate developed. This may have resulted in a considerably inflated estimate, since the New York Inventory was strongly biased towards the surveying of industries with a high rate of waste generation.

No information was incorporated into the report on the predicted fate of wastes, although this was done subsequently to the report and is incorporated into the OWMC Facilities Development Process Phase I Report [OWMC 1982 (c)]. For the 1.5 million tonnes of special waste estimated to be generated per year in Ontario, the following is an estimated breakdown of the present fate of those wastes:

Treated on-site	20%
Treated off-site	25%
Sewered	25%
Municipal landfill	15%
Recycled	10%
Unknown fate	5%

This breakdown is only on the aggregated total, and no similar breakdown is available for individual waste categories.

D.3 OWMC WASTE REDUCTION OPPORTUNITIES STUDY (January, 1983)

[OWMC, 1983]

D.3.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

The purpose of this study was to assess waste reduction opportunities for OWMC. As part of the study, a number of industry interviews were conducted which resulted in development of some waste quantities data. This was reported in an aggregated form in the report to assess the proportion of various waste types which are recycled. Data for individual companies on waste quantities presently disposed off-site, which were not reported in the final report, were subsequently analyzed and compared with waste generation quantities predicted for that company by the OWMC Waste Quantities Study (see Section D.2). A combination of the published and unpublished information is discussed.

D.3.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

The waste quantities were quantities of wastes going to off-site recycling, treatment and disposal. It also addressed quantities of residuals produced by recyclers which require off-site treatment and disposal.

D.2.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

The analysis of data subsequent to publication of the report used only totally aggregated figures for wastes requiring off-site treatment and disposal. Estimates in the published report on wastes being recycled uses no particular categorization scheme. It discusses streams as solvents, waste lubricating oil, pickle liquors, metal containing sludges, oily water, etc., in terms of the percentages of these materials which are reused or recycled.

D.3.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

This study relied solely on generator interviews to develop waste quantities data. It was restricted to 3 industry sectors:

- Chemicals (SIC 28)
- Primary Metals (SIC 33)
- Fabricated Metal Parts (SIC 34)

Interviews were also held with 22 Recyclers within the province of Ontario.

D.3.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

Because it was a very incomplete approach to a waste quantities estimate, no attempt was made to develop an overall Ontario estimate. What was attempted, however, was for the three industry sectors involved to compare the quantities reported in this survey as requiring off-site treatment or disposal, with the quantities predicted by the OWMC Waste Quantities Study as being generated by the three industry sectors. The results suggested that, for the Chemicals and Fabricated Metal Parts sectors, less than 25% of the quantities predicted as being generated would require off-site treatment and disposal facilities. For the Primary Metals industries, only a few reliable estimates of waste quantities were generated, and the results were overwhelmingly influenced by reports of foundry sand being disposed in municipal landfill sites. Without the foundry sand, the ratio for the Primary Metals industry would also be in the order of 20-25% of the projected quantities generated, requiring off-site treatment.

D.3.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

This report has limited usefulness in future waste quantity estimating. The three sectors studied were projected by the OWMC Waste Quantities Study to generate 70% of the industrial waste in Ontario. Extrapolating the 20-25% factor to all of the wastes generated would result in a quantity estimate requiring off-site treatment of 300-375,000 tonnes per year, or 37.5-38 kg/capita.

It is useful from the point of view of documenting quantities of wastes being handled by recyclers. Table D.1 summarises the responses to the survey of Ontario Recyclers with regard to quantities of materials handled.

D.3.7 COMMENTARY

Other interesting information from this study included some estimates of residuals from the recycling industry.

For oil rerefiners, only one company reported any residual waste going to licensed industrial waste treatment and disposal facilities, and that was 2-5 tonnes/year of sludge going to the U.S. The largest oil rerefiner incorporates any residuals into an asphalt product of their virgin oil refinery. Another large rerefiner presently disposes 3,000 tonnes/year of acid clay sludges to a municipal landfill site. This is one waste stream which may be directed by legislation to licensed industrial waste treatment and disposal.

Oily water processors produce three streams, partially reclaimed oil, sewerable water and a residual sludge estimated to be 0.8-5% of their influent volume, for a range of 220-1,400 tonnes/year. This is presently acceptable at municipal landfill sites.

Solvent reclaimers estimate that 5-25% of their influent volume ends up as a residual sludge. The largest solvent reclaimer uses this residual sludge as a boiler fuel. Another company is examining the use of paint sludge in the formulation of cheap paints. Approximately 1,500-2,000 tonnes/year of solvent reclaimers' sludge is presently disposed through off-site industrial waste treatment and disposal facilities.

The pickle acid reclaimers reported no residuals from their operations.

For the minor recycling activities, only the film reclamation and precious metal sludge reclamation activities result in any wastes. These often result in cyanide bearing wastes which must be treated, resulting in a sludge which usually contains lime and heavy metals. No firm estimates of quantities are reported.

TABLE D.1 - Recycling Industry Activities in Ontario, 1982

[Source OWMC Waste Reduction Opportunities Study, 1983, p 6-3]

Primary Ontario Waste Recycling Activities, 1982

Recycled Waste	No. of Companies	Approximate Annual Volume (million litres)
Waste Oils*	6 (4)	112.5 (81)
Oily Water	4	252.0
Solvents	6	33.75
Spent Pickle Acid	2	108.0

*2 of the companies reporting only partially upgraded oils, some of which then go to 2 of the remaining 4 companies, thus some double accounting is included in the 112.5 million litre figure.

Minor Ontario Waste Recycling Activities, 1982

Recycled Waste	Approximate Annual Tonnage (tonnes)
Tin bearing sludges & liquids	60-80
Photographic waste**	> 120
Other precious metal bearing sludges	50-100
Paints	50
Lab chemicals (mainly solvents)	60
Dyestuffs	6

**one company was unwilling to disclose quantities of waste handled

D.4 OWMC EUROPEAN TOUR REPORT (SEPTEMBER, 1982)

[OWMC, 1982 (b)]

D.4.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

It is the report of a tour made of European Waste Treatment Facilities by OWMC staff and consultants in April/May, 1982, during which time information on waste quantities was gathered.

D.4.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

Basically, the estimates in this report are of Special Wastes requiring off-site treatment in a number of European countries visited. Obviously, the definition of Special Wastes varies from country to country, but these variations are not thought to be major and, generally, would be close to that generally accepted in Ontario for major waste categories.

D.4.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

From the point of view of its relevance to Ontario, this report has only totally aggregated waste quantities data with some spotty information on breakdown by means of treatment, i.e. incineration; physical chemical; landfill.

D.4.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

Of the seven estimates shown in Table D.2, four were based on waste quantities reported by actual operating facilities. The other three estimates (England, France and Sweden) are based on government estimates derived in a number of different ways, including surveys of operating waste treatment and disposal facilities.

D.4.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

In this report, the authors used a simple total population ratio to estimate equivalent waste generation in Ontario. Ignoring the one estimate by SARP in France which is believed to have been for market share rather than total special waste generated in France, the remaining 6 estimates for Ontario average about 290,000 tonnes/year $\pm$ 14%.

D.4.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

Because of its totally aggregated estimates, this report has very limited value in detailed analysis of waste quantity estimates for Ontario. As a general bench-mark against which to compare totals of more detailed waste quantity estimates for Special Wastes requiring off-site treatment, it is a valuable estimate, based, as it is, largely on actual experience by operators of waste treatment facilities.

D.4.7 COMMENTARY

While the actual hard numbers available from this report are limited, some of the qualitative comments that were recorded during the tour may be worth recording.

The Hessische Industriemull (HIM) facility in Biebesheim Hessen, West Germany, was based on a waste quantity estimate prior to start-up of 600,000 tonnes/year. After the plant came on stream, it became apparent that this was inflated by a factor of 2 and that the actual waste quantity requiring HIM's facilities was closer to 300,000 tonnes/year. Of this total, 20% was incinerated, 13% treated in the Physical Chemical Treatment Plant, and 67% was disposed in the secure landfill site.

At the Rechem facility in England, comments were made that waste quantities were constantly changing and that the types of waste and their packaging were also highly variable. Advice offered [Baker, 1982] to the tour group was to design any waste treatment facility to be flexible to accommodate such changes.

The GSB facility in Bavaria has seen growth in waste quantities treated from 60,000 tonnes/year in 1972, to 217,000 tonnes per year in 1981. Of this total, in 1981 44% was incinerated, 24% treated in the Phys/Chem plant and 32% sent to a secure landfill. Other waste disposal facilities exist in Bavaria, and GSB exports some wastes for treatment and disposal elsewhere. A total of about 140,000 tonnes were handled in 1981 by these alternatives to the GSB treatment facility. No breakdown of quantities incinerated, landfilled or Phys/Chem treated was reported.

TABLE D.2 - Reported Waste Quantities
European Tour

[Source: OWMC, 1982(b)]

REGION OR COUNTRY (SOURCE OF ESTIMATE)	ESTIMATED ANNUAL QUANTITY OF WASTE (TONNES)	POPULATION (MILLIONS)	ONTARIO EQUIVALENT TONNES/YEAR
Hessen, West Germany (HIM)	300,000	7.5	320,000
Sweden (SAKAB)	250,000	8.0	250,000
England (Department of the Environment)	2,000,000	56.0	290,000
France (Ministry of the Environment)	2,000,000	53.5	310,000
France (SARP)	550,000	53.5	85,000
The Netherlands (AVR)	500,000	14.0	290,000
Bavaria, West Germany (GSB)	360,000	11.0	270,000

D.5 CANVIRO CONSULTANTS MARKETING AND QUANTITIES SURVEY OF LIQUID INDUSTRIAL AND HAZARDOUS WASTES FOR 500 ONTARIO ESTABLISHMENTS [Reported in Canviro: 1985]

D.5.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

This study was undertaken directly for OWMC and is being followed up with a further study of an additional 500 establishments to further refine the waste quantity estimates. The stated study objectives were as follows:

(1) To develop the necessary marketing and waste characteristics data for the planned OWMC treatment and disposal facilities

(2) To develop preliminary estimates of the total quantity, types and fate of special wastes currently generated in Ontario.

D.5.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

This study estimated waste quantities of special wastes at different levels, which included both:

- Special wastes generated by industry in Ontario

and

- Special wastes requiring off-site treatment in Ontario

Figure D.1, taken from the Canviro report, shows the breakdown of waste quantities which have been estimated by the report. The numbers in the Figure are for the 500 companies interviewed, not for all of Ontario, and show the percentages of wastes being treated on-site, stored, sewered and hauled off-site.

D.5.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

This study utilizes the modification to the UCD system of waste classification suggested in the OWMC Waste Quantities Study, 1982, reviewed

in Section D.2. 79 out of the original 106 UCD categories were considered to be "special wastes" to OWMC. It also aggregates these 79 categories into the 14 major groupings suggested in the earlier study, as being descriptive of wastes requiring similar treatment. Table D.3, which is taken, with modification, from Canviro's report, shows the 14 aggregated categories with the UCD types covered by each category. This Table also shows the proportion of each of these 14 categories which make up the overall waste estimate.

D.5.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

This study surveyed some 500 waste generators. The establishments surveyed were randomly selected from the Dun and Bradstreet population data base. Any establishment which was found to be out of business, unable to be contacted, non-manufacturing or unco-operative, was substituted with another establishment from the replacement list.

98 strata representing 49, 2-digit and 3-digit SIC categories with two industry size ranges (less than 10 production employees and greater than 10 production employees) were sampled.

Information on liquid and hazardous wastes was collected for each of the 500 establishments by using a combination of telephone and on-site interviews, along with a comprehensive questionnaire.

The criteria for selecting the number of sample establishments per SIC group were:

(1) The relative contribution of the SIC group to the total waste generation, based on available waste quantity information [the OWMC Waste Quantities Report, 1982]

(2) Specific emphasis was to be placed on major waste generator SIC groups (e.g. 28, 33, 34 and 35). To achieve this, these groups were further subdivided into 3-digit SICs.

(3) Any 2 digit SIC sample groups should contain a minimum of 5 establishments to provide a sufficient statistical basis for data extrapolation.

D.5.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

Extrapolations were carried out utilizing the mean waste generation per sample industry data, which were multiplied by number of Ontario firms in the particular strata.

Two sets of extrapolations were carried out, i.e. one with all industrial data included and another with four outliers' establishments excluded. Outliers were identified as these establishments which had a per production employee waste generation greater than 75 tonnes.

The results were as follows:

	Total Ontario Waste Generation (tonnes/year x 10^3)	90% Confidence Interval (tonnes/year x 10^3)
All data included	1,650	$\pm$ 680
Outliers excluded	1,310	$\pm$ 565

D.5.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

This report, plus the follow-up study on an additional 500 companies, is going to be extremely useful to future waste quantity estimates and also to assessing markets for OWMC's treatment and disposal facilities. It is certainly the most broadly based generator interview survey specifically on Ontario waste generators that has been undertaken to date. Its weakest point is in the extrapolation of data, because of the weakness of the D and B information for the purposes of waste estimation. The combination of the Canviro study with the results of the data base review study [OWMC Market Assessment ProgramInitial Capacity Project: "Evaluation of industrial Data Bases"] should further increase the usefulness of this study.

D.5.7 COMMENTARY

This study appears to have been thoughtfully designed to develop data on a number of the critical parameters which affect present and future waste quantities. It is also well designed to retrieve data on potential markets for treatment and disposal facilities. The data available on each UCD waste stream from individual company sites generating that type of waste is listed in Table D.4. Searches of the data can be made using IBM and IBM compatible personal computers.

One rather surprising result of the study was the great discrepancy of specific waste production factors between the small and large companies in some industry sectors.

		Tonnes/year/employee < 10 Size	> 10 Size
SIC 28	Chemicals	4.4	5.5
SIC 37	Primary Metals	21.2	15.1
SIC 37	Transportation Equipment	0.2	1.2
SIC 32	Stone, Clay, Glass and Concrete Products	< 0.1	3.8
SIC 36	Electrical & Electronic Machinery	0.4	3.3

It would be very interesting to break down the > 10 size of companies into further intervals, to refine the extrapolated estimate. It is understood that the follow-up study of a further 500 establishments will be breaking this group into 5 size intervals.

As was noted above, the accuracy of the extrapolated data in this report is adversely affected by the inaccuracies of Dun and Bradstreet's business information, and that a better set of business data would refine the data. Another shortcoming of this study is that it relies solely on reported data, with no verification of reported numbers. It is not suggested that companies would deliberately lie about waste quantity data, but rather than they may be unaware of the actual generation or fate of wastes. This is borne out by the fact that approximately 25% of the wastes removed from the site ended up at a destination unknown to the respondent. Canviro's subjective assessment of "Accuracy of Data" might help to alleviate this shortcoming. Searches could be undertaken, restricted to data described as "excellent" or "good" and ignoring data described by the interviewer as "fair".

TABLE D.3

[Source: Canviro, 1985]
(Modified and corrected for arithmetic errors)

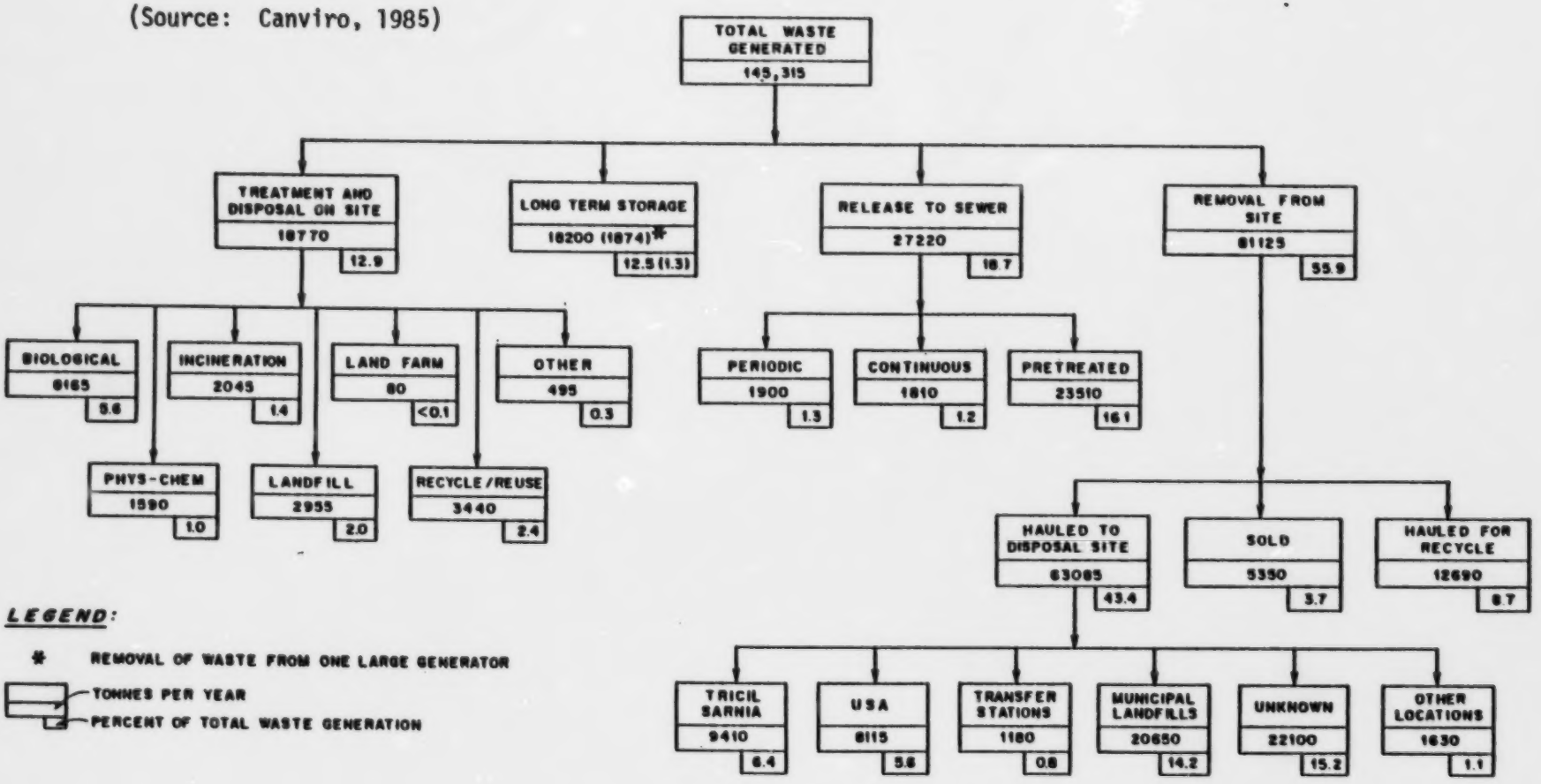
Description of Waste Group 1	UCD Codes	% of Wastes
Organic Sludges and Still Bottoms	247, 248, 261, 252, 523, 263, 529, 446, 257	7.9
Solvents & Organic Solutions	211, 212, 213, 214, 215, 216, 217, 221, 222, 223, 224	1.7
Oils and Greases	281	1.3
Oil/Water Mixtures	283	< 0.1
Organic and Oily Residues	264, 282, 284, 285, 286, 288, 289, 447	14.0
Heavy Metal Solutions and Residuals	111, 112, 131, 121, 122, 123, 131, 132, 133, 141, 142, 143, 244, 251, 431, 433, 445, 523	39.3
Miscellaneous Chemicals and Products	145, 152, 243, 245, 416, 513	0.3
Paint and Organic Residuals	254, 258, 262, 454, 455	3.2
Aqueous Solutions with Organics	225, 226, 227, 228	< 0.1
Anion Complexes	146, 147, 444	0.1
Sludges and Inorganic Residuals	151, 165, 167, 417, 441, 443, 518, 509	31.5
Pesticide and Herbicide Wastes	241, 532	< 0.1
PCB Wastes	242	< 0.1
Clean-Up Residuals	512, 521, 528, 531	0.5

TABLE D.4 - Data Available on Each UCD Waste Stream Generated by an Individual Company's Plant

Number of Production Employees
Wastewater Pretreatment Capability
SIC Group
Production Statistics
Region of Ontario
UCD Classification
Overall Physical Description of the Waste at 70°F
Pumpability
pH
Percent Total Solids
Organic/Inorganic Content
Fuel Value
Flash Point
% Water
Composition (major constituents)
Typical Concentrations
Constituents of Concern
Fire Explosion Hazard
Storage Method
Storage Time
Disposal Method (current)
Hauler Name (for off-site disposal)
Disposal Location
Use of Waybill System
Present Waste Quantities
Future Waste Quantities
Potential for Waste Reduction, Reuse and Recycle
Disposal Cost
Transportation Cost
Assessment of the Accuracy of the Information

FIGURE D.1

(Source: Canviro, 1985)



FATE OF LIQUID INDUSTRIAL AND HAZARDOUS WASTES GENERATED (TONNES/YR) BY 500 INDUSTRY SAMPLE GROUP

D.6 CANVIRO CONSULTANTS LTD. AND SIMCOE ENGINEERING LTD. AN INVENTORY OF LIQUID AND SPECIAL WASTES FOR THE REGIONAL MUNICIPALITY OF WATERLOO

[Canviro, 1982]

D.6.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

The overall objective of this study (published april, 1982) was 'to determine the quantities, types and fate of liquid and special wastes currently being generated by industry, institutions and other selected commercial establishments in the Region of Waterloo'. However, 'all wastes with the exception of uncontaminated solid wastes and process wastewaters discharged to sewers were considered to be liquid or special wastes'. Consequently, wastes such as those from the food processing industry, which are not of interest to OWMC, have been included in the estimates. This reduces the significance of the data generated to OWMC.

In addition to waste quantity data, the study contains information concerning waste characteristics, waste storage and treatment/disposal methods and future waste generation estimates, all of which are of interest to OWMC.

D.6.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

A total of approximately 45,243,000 litres/year of liquid wastes and 185,000 tonnes/year of special solid wastes was estimated to be produced in the Region. Special wastes were classified as either contaminated solid wastes (e.g. foundry sands, dusts, organic solids, contaminated wood or paper and uncured rubber) or miscellaneous special wastes (e.g. pesticides, herbicides, PCBs, pathological wastes, explosives, asbestos-containing wastes, radioactive wastes and miscellaneous laboratory wastes). Miscellaneous special wastes amounted to 946,000 litres and 196 tonnes per year.

Non-hazardous food processing wastes accounted for 26.24 million litres/year and 73,194 tonnes/year of liquid and solid waste generated in the Region. Foundry sands accounted for approximately 50% of the special wastes generated in the Region.

Excluding the food industry liquid wastes, the MOE waybills accounted for 71% of the remaining liquid wastes generated in the Region.

D.6.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

The authors of this study classified wastes into the following groups:

- Organic liquids
- Inorganic liquids
- Organic sludges
- Inorganic sludges
- Solids
- Miscellaneous special wastes

The major groups were further divided into 41 individual waste types.

In addition to making its waste quantities estimates based on the above classifications, the report also presented a summary of quantities of industrial wastes hauled from the Region of Waterloo according to 1981 waybill records.

Wastes were also categorized in terms of their corrosivity, reactivity, toxicity and ignitability.

The characteristics, quantity and fate of any individual waste from any specific industry can be readily identified by means of the program and data files generated during the study.

D.6.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

Questionnaires were completed by the interviewers either over the telephone or by site visit. In general, on-site interviews were done for most of the large industries (based on number of employees and/or water usage) or when prior knowledge indicated an industry's potential for generation of large quantities of waste. On-site interviews were conducted with 58 industries, equivalent to approximately 20% of those industries which produced some type of liquid or special wastes.

D.6.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

This report found no apparent correlation between the quantities of wastes generated and such industry characteristics as number of employees and water use, on an industry-wide basis. However, the report states that further data analyses could yield a better correlation between wastes generated and number of employees within each classification.

The report does not attempt to extrapolate reported waste quantities to Ontario data; the study is strictly regional.

D.6.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

This study is of only marginal use in any future waste quantity estimate for Ontario. The study is regional and includes many wastes not of interest to OWMC.

D.7 McLAREN REPORT ON "THE SITING OF FACILITIES AND THE MANAGEMENT OF LIQUID INDUSTRIAL AND HAZARDOUS WASTES IN ONTARIO (NOVEMBER, 1980)

[McLaren, 1980]

D.7.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

This study was completed prior to the creation of OWMC, and to some extent was responsible for its creation by the Ontario Government in 1981.

D.7.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

This study is entirely based on MOE Waybill data (see Section D.12) for 1979. It is, therefore, estimating the total quantity of hauled liquid industrial waste for off-site treatment and disposal during 1979. No solid special wastes are included in the data.

D.7.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

This study uses the 23 MOE waybill waste categories (see Section D.12). For the 1979 data reported, nearly 50% of the waste volume fell into three categories:

- Oily water
- Other inorganics
- Inert sludges

None of these categories is very definitive and would be of limited value in specifying safe treatment and disposal methods.

D.7.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

This report relied entirely on the waste quantity data available from the MOE waybill. It is, therefore, a direct measure of reported quantities of hauled liquid industrial waste. In 1979, the Waybill system was 2-3 years old and was still being refined and modified, as it still is today (see Section D.12). While the majority of liquid wastes going to off-site treatment and disposal were reported on the manifest, a small volume of waste was being missed in those early days as companies became used to the new requirements for reporting.

D.7.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

Since this report utilized waybill data reported for the whole of Ontario, no extrapolating procedure was necessary.

D.7.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

Since this report used 1979 MOE waybill data, it is thought to be of no use to future waste quantity estimates. MOE are refining and updating their data on a continuing basis, and these estimates certainly will be of great significance to future estimates.

D.7.7 COMMENTARY

While this report is not regarded as being particularly useful for future waste quantity estimates, it is interesting that the total quantity of liquid wastes hauled off-site in 1979 was 275,000 tonnes or 34.4 kg/capita assuming an 8 million population for Ontario. This agrees well with estimates for Europe, New York State and California which range from 28 to 40 kg/capita waste generated for off-site treatment.

D.8 GORE AND STORRIE LTD. - CANADIAN NATIONAL INVENTORY OF HAZARDOUS AND TOXIC WASTES

[Gore and Storrie, 1982]

D.8.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

This study, which was published in January, 1982, provides estimates of the quantities of hazardous and toxic wastes being generated in Canada, and in each individual province, including Ontario.

The purpose of the study was to provide 'an "umbrella" data base bringing together State-of-the-Art quantity information that has been developed primarily in the last decade on this continent, i.e. in the U.S.A. and Canada'. The data base would then be available for use by various federal and provincial agencies and other parties in their considerations and actions with respect to protecting the environment against the presently recognized adverse effects of failing to control hazardous and toxic wastes from the point of initial generation to final disposal.

Obviously, this study is of prime interest to OWMC in their efforts to estimate Ontario's Special Wastes generation rate.

D.8.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

This report estimates total hazardous and toxic waste quantities being generated by each SIC 4-digit group in Canada. Some waste streams are identified by their hazardous characteristic(s), i.e. toxic (T), corrosive (C), reactive (R) and ignitable (I) as defined by the EPA.

D.8.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

This report categorizes waste streams by SIC classification. A master list of hazardous and toxic waste streams is made up for some 100 4-digit SIC

groups. This master list presents information in the following manner:

Sic No.	Manufacturing Groups	Products	Hazardous Wastes: Waste Stream	Hazardous Components	Tonnes per Year

The study then summarizes this information with tables giving quantities of hazardous waste by Province for the three main industry groups (i.e. Chemicals, Metals and Other) and for each individual 4-digit SIC group.

This listing of Canadian industries is derived from a computerized listing which was purchased from Dun and Bradstreet.

D.8.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

The report used a totally aggregated estimate based on SIC classification and U.S./Canadian generation factors estimated from past studies and reports (mostly EPA reports published between 1973 and 1980). The waste generation factors were derived using production and sales/employee data. In arriving at these generation factors, the report assumed that the level of industrial manufacture in Canada is the same as that in the U.S.

It did not generate any survey data of its own.

D.8.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

As has been mentioned previously, hazardous waste generation factors, based mostly on U.S. data, were established for each 4-digit SIC group. These factors were in tonnes of waste/employee/year.

The computerized listing purchased from Dun and Bradstreet gave the necessary breakdown of industry in Ontario.

The study estimates nearly 50% of total Canadian hazardous waste is generated in Ontario, i.e. 1,605,107 tonnes/year.

D.8.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

This report has limited usefulness to OWMC in assessing the need for treatment facilities in Ontario. The data are presented in too aggregated a form to be of great utility. There are also questions about the accuracy of the input data.

D.8.7 COMMENTARY

The authors of this study emphasized the fact that these quantity and rate numbers are only approximations, and that there were great differences between the methodologies and criteria employed in the reports they used as references.

From Volume 2:

> "It must be understood that with the variety of consultants involved, each researching hazardous waste generation and disposal practices utilizing their own individual methods, that there can be appreciable differences in waste definitions and descriptions as well as waste quantity assembly, completeness and accuracies, even though in many cases industries were approached either directly or indirectly to make the information as complete and reliable as possible
>
> "It also should be appreciated that within any one industry category or group, the quantity generation of liquid hazardous wastes can vary appreciably, simply because of concentration differences. With the enormous variety of hazardous liquid wastes, especially from the thousands of chemical products associated with generation of wastes, as yet a common basis of agreement on standard waste strength does not exist"

D.9 REID CROWTHER - HAZARDOUS WASTES IN N.W. CANADA

[Reid Crowther, 1980]

D.9.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

This study was carried out in 1980 on behalf of Environment Canada by Reid Crowther and Partners Ltd. The report is divided into 5 specific areas, one of which is an inventory of hazardous waste in the region. The other topics covered are transportation practices, treatment and disposal practices, existing legislation and experience elsewhere.

The inventory of hazardous waste looks at the types and quantities of wastes generated by industry in northern and western Canada, and so actual figures are of little relevence to OWMC. However, as with any study of this nature, the methodology used to generate these figures, as well as information on the waste stream categories, are always of interest. In addition, this study was utilized in the OWMC Waste Quantities Study discussed in Section D.2. The quantities reported by the study for the amount of hazardous waste generated per person per year are of value for comparison with other studies.

D.9.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

The waste quantity reported is the total hazardous waste quantity which 'would be available to a disposal facility if one were constructed and legislation implemented directing all such wastes to the facility'. Hazardous wastes were defined as those which could be characterized into seven categories:

(1) Ignitable
(2) Corrosive
(3) Reactive

(4) Toxic
(5) Infectious
(6) Bioaccumulative
(7) Mutagenic, carcinogenic and teratogenic

The total hazardous waste quantity reported was 246,400 tonnes, of which 4,400 tonnes were generated in N.W. Ontario.

The estimate excludes non-hazardous wastes such as electrolytes from mining operations, contaminated soil, sand and drilling muds from extractive industries and waste types that were generated in insignificant volumes. Wastes, which were at the time being treated successfully (e.g. arsenic trioxide at Yellowknife), were also excluded from the totals.

D.9.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

A system was adopted for this study whereby waste streams were placed into 40 waste categories under the following headings, and then further grouped into 15 waste management categories:

- PCBs
- Oils
- Solvents
- Sludges
- Pesticides
- Process
- Aqueous Metal Wastes
- Acids
- Alkalis
- Concentrated Organics
- Other

The major waste generators were found to be the oil refiners (2911) at 4.55×10^5 tonnes/year and steel mills and iron foundries (3312, 3321) at 1.84×10^5 tonnes/year.

D.9.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

The methodology used was based on existing statistical data. Unit waste generation ranges per production employee were obtained from a literature search, particularly for New York State [Iannoti et al, 1979], and these rates were applied to data on locations, types and sizes of industry in the study area.

The literature review provided information 'on the relationship between 4-digit standard industrial classification (SIC) groups, waste streams, and associated generation rates'.

Dun and Bradstreet market information resources were used to provide the geographical distribution and size of waste generating SIC groups (total number of employees).

The report also priorized the hazardous waste group for management planning purposes, drawing attention to those wastes requiring immediate attention. The three criteria used in this priorization were hazard, volume and bioaccumulation.

All employee numbers used in this study were production employees only.

A 'summary of the inventory analysis' was obtained by entering the variables; industry type, industry size, geographic location, waste type, generation rate and management category into a computer program. Approximately 4% of the total waste reported was generated by interviewed establishments.

D.9.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

The amount of hazardous waste generated was based on extrapolation of waste figures from 3,228 plants in 203 SIC categories identified in Western Canada. This was thought to represent over 90 percent of the total volume of hazardous wastes in the region. This assumption was made based on hazardous waste inventory information from the New York State (see Section D.15) survey. It is notable that the New York Inventory employed a targeted survey of major suspected waste generators; hence, it was not a statistically random survey.

It is not possible to extrapolate the waste quantities generated in this region to those that are generated in Ontario, though the methodologies used in the study could be used in a similar study on Ontario waste generation. It is cautioned, however, that the extrapolation technique must be based on a statistically valid sample.

D.9.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

This report is of marginal interest to OWMC.

D.9.7 COMMENTARY

The authors of this report recognize and note a number of limitations to preparing accurate inventories [Reid Crowther, 1980, pp 38-39].

A comparison of northern and western Canada inventory results with other jurisdictions is presented in Table D.5 [Reid Crowther, 1980, p 53]. The absolute value of this table is rather limited because of a number of waste categories which were excluded from the waste volumes, to facilitate comparisons between jurisdictions. The absolute values are, therefore, low since acids, alkalis and a number of other wastes are excluded.

TABLE D.5 - Comparison of Northern and Western Canada Inventory Results with Other Jurisdictions*

[Source: Reid Crowther, 1980]

Data Collection Method	Reference	Jurisdiction	Population	Annual Waste Volume (tonnes)	Hazardous Waste Generated kg/Person/Year
Report Results					
Generation Rate Inventory	This Report	Northern and Western Canada	6,400,000	124,000	19
Canadian Surveys					
Extrapolative Inventory	Kinetic Contaminates, 1979	Northern and Western Canada	6,400,000	83,204	13
Questionnaire Inventory	Associated Engineering, 1972	Alberta	1,800,000	25,900	14
Questionnaire Inventory	Siemieniuk, 1979	Yukon	25,000	510	20
Questionnaire Inventory	Environment Canada, 1979	City of Vancouver	415,000	5,000	12
Manifest Data	MacLaren, 1979a	Ontario	8,000,000	136,000	17
Questionnaire Inventory	Kinetic Contaminates, 1979	Prairie Provinces, NWT, N.W. Ont.	4,000,000	61,200	15
United States Surveys					
Questionnaire Inventory	Fennelly et al, 1976	Massachusetts	5,800,000	101,000	17
Questionnaire Inventory	Fennelly et al, 1976	Minnesota	1,900,000	54,000	28
Questionnaire Inventory	Oregon, 1974	Oregon	2,200,000	35,000	16
European Surveys					
Inventory	Site Visit -1979	West Germany	60,000,000	1,200,000	20
Inventory	Site Visit -1979	Denmark	5,000,000	88,000	18
Inventory	Site Visit -1979	Netherlands	15,000,000	420,000	28

*NOTE: Table excludes acids, alkalies, recoverable and dilute oils, and dilute aqueous wastes to facilitate comparison between jurisdictional areas.

D.10 EPS, ATLANTIC REGION - HAZARDOUS WASTES INVENTORY REPORT [EPS, 1980]

D.10.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

The Environmental Protection Service, Atlantic Region of Environment Canada undertook an assessment of the quantity of hazardous wastes requiring disposal to enable them to develop a "comprehensive regional hazardous wastes management system". The assessment was based on a survey conducted over 1978 and 1979 of waste generators in Nova Scotia, New Brunswick and Prince Edward Island.

This study was one of the first surveys of hazardous wastes conducted in Canada. Its relevance to OWMC lies in its use of data extrapolation by SIC group. (It is cautioned, however, that this study employed the Canadian SIC, rather than the U.S.A., SIC system).

D.10.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

Three segments were identified on the basis of other surveys and regulatory agency experience as likely "significant sources of hazardous waste" viz. manufacturing industry, federal facilities and institutions, e.g. hospitals and universities. Each segment was surveyed separately, using somewhat different methods. The manufacturing industry was considered the most important contributor and was further scrutinized to identify 455 "potential generators" out of the 1560 manufacturing companies in the Maritime provinces. The selection process employed the following rationale:

(1) companies employing less than 5 people were excluded as insignificant generators

(2) major industrial groups, viz. SIC's 1000 (food and beverage), 1500 (tobacco products), 2400 (clothing manufacturers) and 3900

(miscellaneous manufacturers) were excluded as "non-producers", i.e. companies which do not generate any hazardous waste.

(3) some manufacturing sub-groups were also identified as non-producers, e.g. 1840 (cordage and twine industry) based upon the manufacturing processes employed and "basic chemical engineering principals".

Manufacturing trade directories from each Province were employed to identify specific firms for the inventory.

D.10.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

The survey employed a definition of hazardous waste similar to that contained in the U.S. EPA RCRA rules and regulations.

Fifteen broad waste classes were employed in the study and are shown below:

1. Acid solution
2. Alkali solution
3. Pesticides, herbicides and biocides
4. Paint sludge
5. Solvents
6. Tetra ethyl lead sludge
7. Chemical toilet sludge
8. Tank bottom sediment
9. Oil: waste or contaminated
10. Drilling mud
11. Contaminated solid and sand
12. Food processing waste
13. Latex waste
14. Restricted waste (e.g. PCBs)
15. Other

Three of the waste categories, viz. food processing wastes, drilling mud and chemical toilet wastes, were excluded on the basis of low hazard and the availability of on-site treatment.

D.10.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

Claiming that the 455 potential generators among Maritime manufacturers was too large a number to be surveyed, 110 companies were selected on the following bases:

(1) large and small firms were to be included
(2) a greater representation of "serious generators", e.g. petroleum refiners, was required.

Questionnaires were sent to each industry and, subsequently, an interview arranged with the plant manager.

The survey questionnaire requested data on the type, quantity and frequency of waste disposal to be supplied by the industry representative. Lists of example materials were included to further describe each waste type. Additional information was obtained with the assistance of the interviewer on the management of the wastes. This included details on treatment, storage, reuse and disposal of wastes, including the type of containers employed. The questionnaire also requested feed back from the industry regarding disposal problems.

Only two of the 110 companies selected did not consent to an interview.

Details on the nature of potential hazard presented by wastes were not collected in the survey.

D.10.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

Results of the survey of the 110 selected manufacturing companies were extrapolated to represent the 455 potential sources on the basis of employment. To effect the extrapolations, industries were divided into groups according to product similarities. This resulted in some four digit SIC groups being combined.

Data extrapolated from the survey were used for the following ends:

(1) determination of total load kilometers of all or selected portions of waste trucked to a central facility
(2) evaluation of the adequacy of current waste management
(3) identification of alternative management scenarios.

D.10.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

The report acknowledges some potential shortcomings of the methodology employed, as follows:

(1) the assumption that the waste generation rate per employee is uniform within an industry group does not reflect possible process differences.
(2) Accuracy of the survey results was dependent upon the "willingness" and "honesty" of plant managers.
(3) Changes in plant operation and process may make some results outdated.

The amount of waste generated on a per capita basis for the population of the Maritimes was calculated for each of 5 scenarios

presented, and compared to the range of per capita rates reported by other surveys. The rate reported was in the lower range, which was attributed to the comparative lack of industrial development.

D.10.7 COMMENTARY

This was one of the first studies to employ the technique of extrapolation by SIC group and sample versus total employment to obtain hazardous waste estimates.

D.11 CCPA - ONTARIO INDUSTRIAL HAZARDOUS WASTE SURVEY [CCPA, 1981]

D.11.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

This study, which was completed in December, 1981, estimates an annual industrial hazardous waste generation rate for Ontario, and so is of real value to OWMC.

The study methodology did not involve waste estimate extrapolation and reports only those quantities reported by the industries interviewed.

D.11.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

The figure reported in this study is the quantity of hazardous waste produced by an undefined percentage of Ontario industry. The study used the following definition for a hazardous waste:

> "-- those wastes which, due to their nature and quantity, are potentially hazardous to human health and the environment, could potentially be applied to the land, and require special disposal techniques to eliminate the hazard. Excluded are 'Hazardous Wastes' which are recycled, or consumed in subsequent processing operations, and those which receive pretreatment and are discharging along with liquid effluent"

The study reports 99,570.3 x 10^3 litres of liquid waste and 436,087.1 tonnes of solid wastes generated (or 535,657.4 tonnes total). The percentage of this waste that appears on waybills is 17.6% and the percentage receiving preferred treatment is 76.8%. Preferred treatment/disposal includes techniques such as incineration, solidifcation, secure landfill, physical/chemical treatment, neutralization, reuse, biological treatment and landspreading.

At the request of the client, the following wastes were not included in the final estimate:

- human waste
- approved wastes going to an approved sewage treatment facility
- industrial refuse and garbage (broken pallets, scrap machinery, etc.)

Wastes disposed of in-house were not necessarily included either.

D.11.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

The Waybill categorization system was used in this study. An annual waste quantity generation figure for each category was reported. Individual waste streams within each category were reported, though waste quantities for these were not.

Indications were provided on a percentage basis of how much of each waste category was being listed on waybills.

A percentage was also given of the amount of total waste within each category receiving "preferred treatment".

Hazard ratings for all the waste streams in each category were summarized and included.

D.11.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

The CCPA gathered the information for this report through a number of provincial and national associations representing primary manufacturing industries. Each association conducted its own survey under the direction

of the CCPA, who then analyzed the data. A list of those associations that participated is given below:

- Canadian Agricultural Chemicals Association
- Canadian Chemical Producers Association
- Canadian Fertilizer Institute
- Canadian Manufacturers Association
- Canadian Manufacturers of Chemical Specialities Association
- Canadian Paint and Coatings Association
- Canadian Pulp and Paper Association
- Canadian Steel Environmental Association
- Motor Vehicle Manufacturers Association
- Ontario Hydro
- Petroleum Association for the Conservation of the Canadian Environment

D.11.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

The survey reports actual reported waste quantity figures only. The data were compiled and aggregated by the participating industry groups. Extrapolation methodology was not used.

The percentage of Ontario industry that participated in the survey is not given.

D.11.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

This report is useful in the sense that the data it provides is reported data and not extrapolated. However, its value is reduced by the fact that waste generation rates by industry sector were not given nor was the number of companies that took part in the study.

D.11.7 COMMENTARY

Had more information concerning the number of companies that were represented in the study been made available, it would add to the value of this study tremendously.

D.12 MINISTRY OF THE ENVIRONMENT ONTARIO WAYBILL

[Ministry of the Environment Ontario, 1984]

D.12.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

The Ontario Waybill records provide valuable information on the fate of those liquid industrial wastes hauled off-site to an approved facility. Twenty-three waste categories are listed against nine different waste destinations. Trends in the reclamation or reuse of various waste streams can be followed yearly, as can the quantities of liquid industrial wastes going to Tricil, municipal landfills, private landfill/farm, incineration, pollution control plants, out of province, and transfer stations. Waybill data are also of value when ground-truthing waste quantity estimates produced using generation factors. Each year, more wastes are waybilled, thus increasing the amount of real data available on generation rates.

Summaries of 1982 and 1983 Waybill data are shown in Appendix C [Ministry of the Environment Ontario, 1984].

D.12.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

The MOE Waybill system provides a record of all industrial liquid waste hauled in Ontario. The term 'liquid industrial waste' means liquid waste that is a product of:

(i) an enterprise or activity involving industrial, manufacturing or commercial processes or operations
(ii) research or an experimental enterprise or activity, or
(iii) an enterprise or activity to which subclause (i) would apply if the enterprise or activity were carried on for profit,

but does not include:

(iv) waste that is a product of a sewage system
(v) waste discharged at the generation site into the municipal sanitary sewer works in accordance with applicable by-laws
(vi) waste disposed of at a waste disposal site operated by the producer of the waste and located on the site where the waste is produced
(vii) waste that is wholly used or recycled.

In 1982, the total quantity of liquid industrial waste recorded on the waybill system was 195,685 tonnes after netting out Transfer Station records. This figure increased to 290,410 tonnes in 1983, an increase of 48%.

Included in this increase is a doubling of waste going to reclaim/reuse from about 31,000 tonnes in 1982. The other large increase is in wastes reported as going to pollution control plants. These increased from 20,000 tonnes in 1982 to 95,000 tonnes in 1983.

D.12.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

The MOE Waybill system classifies wastes into twenty-three categories which are shown in Appendix C. It lists the volumes of each waste stream finding the following fates:

- Tricil Landfill
- Municipal Landfills
- Private Landfill and Farm
- Incineration
- Pollution Control Plants
- Out of Province
- Reclaim/Reuse

- Miscellaneous
- Transfer Stations

D.12.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

Waste quantity data is generated through a system whereby the waste generator, waste receiver and waste hauler provide certain information concerning type, quantity and disposal of a liquid industrial waste stream by completing a Ministry of Environment docket which accompanies the waste from the generators gate to the point of disposal. A sample copy of this docket or waybill is shown in Figure D.2. The system provides a written record of all liquid industrial wastes that are hauled from the generator's premises and disposed of in the correct manner within or outside the Province.

D.12.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

This method is an actual recording method and does not extrapolate to achieve waste quantity data. Figures reported are not waste quantity estimates.

D.12.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

The Waybill records are extremely valuable as checking devices for any Ontario waste quantity estimate. However, the system does not account for solid Special Wastes which are of interest to OWMC also, and any liquid industrial waste which is not waybilled. The Waybill system also gives no estimate of the quantity of special waste which is treated by industry on-site.

D.12.7 COMMENTARY

The MOE Waybill system is currently under revision. Items excluded from the 'liquid industrial waste' definition are being expanded to include:

- food wastes
- drilling fluids and produced waters associated with exploration, development or production of crude oil or natural gas
- processed organic wastes (Reg. 309)
- waste from motor vehicle service facilities
- asbestos waste

Greater control of waste transfer is being covered by increased definitions of responsibilities. In addition to the revision of Regulation 313, a completely new and extremely detailed generator regulation is being proposed which will clearly outline the generator's responsibilities to ensure correct disposal of his waste stream.

Another exclusion from the liquid industrial waste category is for "recyclable material". The definition for recyclable material is as follows [Ministry of the Environment Ontario, 1983]:

"recyclable material means waste

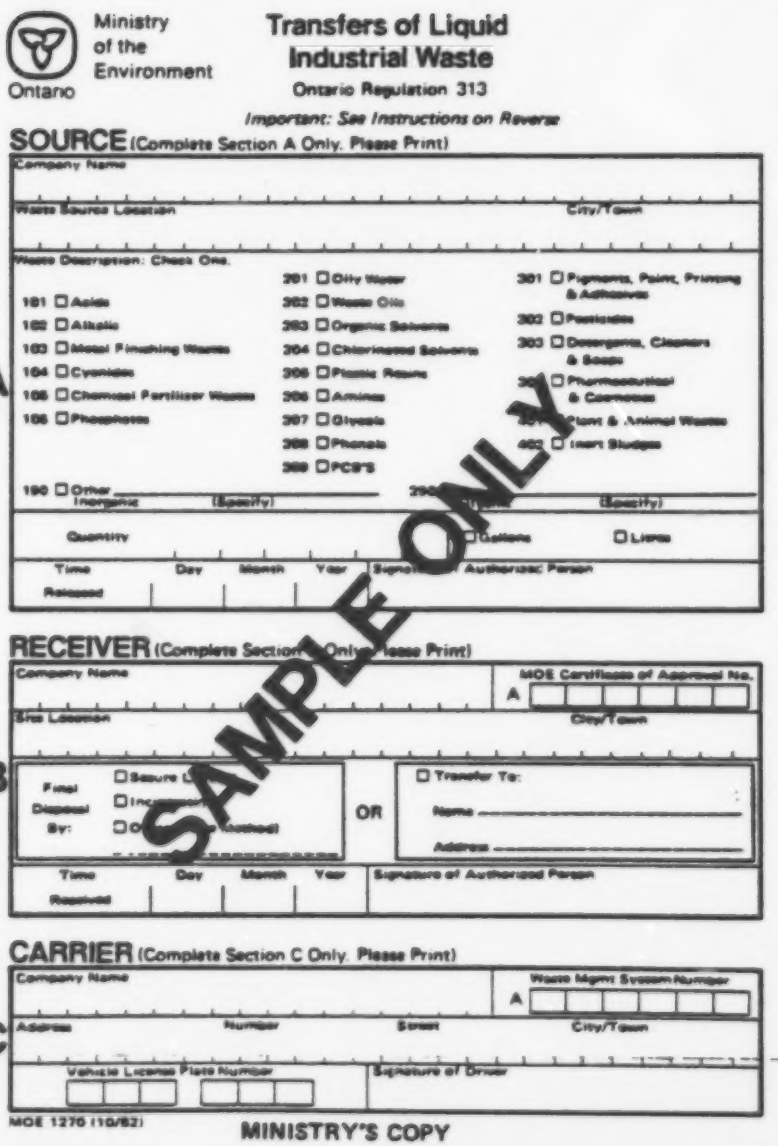
(a) that is to be transported directly from a generator to a person

(i) who will wholly utilize it in a commercial or industrial process used principally for functions other than waste management and which does not involve combustion of waste;
(ii) who will wholly utilize it as a dust suppressant, or
(iii) who will package or offer the waste for retail sale, or

(b) that is to be transferred, bulked, processed, or otherwise treated in existing and on-going facilities for retail, commercial or industrial use, reuse, recycling or reclamation

but does not include hazardous waste, site-specific waste, and liquid industrial waste."

FIGURE D.2 - Sample Copy of an MOE Waybill



Ministry of the Environment
Ontario

Transfers of Liquid Industrial Waste
Ontario Regulation 313

Important: See Instructions on Reverse

SOURCE (Complete Section A Only. Please Print)

Company Name

Waste Source Location — City/Town

Waste Description: Check One.

101 ☐ Acids
102 ☐ Alkalis
103 ☐ Metal Finishing Wastes
104 ☐ Cyanides
105 ☐ Chemical Fertilizer Wastes
106 ☐ Phosphates
201 ☐ Oily Water
202 ☐ Waste Oils
203 ☐ Organic Solvents
204 ☐ Chlorinated Solvents
205 ☐ Plastic Resins
206 ☐ Amines
207 ☐ Glycols
208 ☐ Phenols
209 ☐ PCB's
301 ☐ Pigments, Paint, Printing & Adhesives
302 ☐ Pesticides
303 ☐ Detergents, Cleaners & Soaps
☐ Pharmaceutical & Cosmetics
☐ Plant & Animal Wastes
402 ☐ Inert Sludges
190 ☐ Other Inorganic (Specify)
(Specify)

A

Quantity ☐ Gallons ☐ Litres

Time Released | Day | Month | Year | Signature of Authorized Person

RECEIVER (Complete Section B Only. Please Print)

Company Name — MOE Certificate of Approval No. A

Site Location — City/Town

B

Final Disposal By: ☐ Secure L... ☐ Inc... ☐ O... (Specify Method)

OR

☐ Transfer To:
Name
Address

Time Received | Day | Month | Year | Signature of Authorized Person

CARRIER (Complete Section C Only. Please Print)

Company Name — Waste Mgmt. System Number A

C

Address — Number — Street — City/Town

Vehicle License Plate Number | Signature of Driver

MOE 1270 (10/82)

MINISTRY'S COPY

SAMPLE ONLY

D.13 MITRE REPORT

D.13.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

This study presents estimates of the quantities of hazardous waste generated by both manufacturing and non-manufacturing sectors in the U.S. However, the quantities estimated are based on 1975 generation data, so both the quantities and generation factors are probably outdated.

Extrapolation was based on total number of employees, though the reference studies used employed production as well as total employee figures.

D.13.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

This study estimates the total amounts of hazardous wastes generated by each industry (i.e.SIC Nos. 20, 22-39) in each of the ten Environmental Protection Agency Regions in the United States. Based on these estimates, manufacturing industry generated 47.5 million tonnes of hazardous waste in 1975. Approximately 60% of this, or about 28.7 million tonnes was generated by industries in SIC code 28 (Chemicals and Allied Products).

The study also estimates quantities of potentially hazardous waste emanating from non-manufacturing industries. However, it does note that there is a great variation in the degree of hazard associated within the waste categories discussed in this sector.

D.13.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

Waste generation factors were derived for each two digit SIC group in the manufacturing sector, with the exception of SIC 21 (Tobacco manufacturing). Totally aggregated estimates are presented for each SIC group.

D.13.4 WHAT METHOD DID THE STUDY USE TO GENERATE WASTE QUANTITY DATA?

Generation factors were calculated for industry groups categorized by the two-digit SIC codes 20, 22-39. Data from eight States and one EPA region were used as information sources.

These factors 'were developed based on the assumption that the ratio of the amount of hazardous waste generated by an industry to the number of employees in that industry is approximately constant among all establishments within each industry grouping at the two-digit SIC level'.

Tables presenting data sources for generation factors and the derived generation factors are presented in the report.

D.13.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

This study employed information generated by nine previous U.S. surveys. Most of these reports used the total number of employees as a basis of extrapolation from individual companies to State-wide waste volumes. However, the authors recognized that use of production employees only might have provided a more accurate extrapolation.

It was thought that the data in the reference reports used were more adaptable for extrapolation using total number of employees as opposed to production employees.

D.13.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

This report estimates the total quantity of hazardous wastes generated in the U.S. in 1975, so the figures and possibly the generation factors are out

of date. The report is marginally useful for comparison of waste generation estimates with other reports. The report also includes critical analyses of each of the surveys employed in the report for the development of generation factors.

D.14 CALIFORNIA ALTERNATIVES TO LAND DISPOSAL OF HAZARDOUS WASTES (1981)

[California, 1981]

D.14.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

This study was reviewed by the OWMC Waste Quantities Study Team (see Section D.2), but was not used as a primary data source in the model used to predict waste quantities. It is a useful benchmark study against which to judge waste quantity estimates , being undertaken for a highly industrial jurisdiction akin to Ontario.

D.14.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

This report estimates the quantities of industrial waste disposed to land in Class I and Class II-1 (defined by California State Regulations) secure landfill sites.

D.14.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

This report uses the University of California of Davis (UCD) waste categorization system. Some UCD waste categories were included as part of their "hazardous waste" quantity estimate which have been excluded from OWMC's current definition of Special Wastes. The total quantity reported, including all UCD categories, was 1.24 million tonnes/year. If the UCD categories not of concern to OWMC are eliminated, this total is reduced to 925,000 tonnes/year.

D.14.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

California Department of Health Services Liquid Waste Hauler Records were reviewed for two months, September, 1979, and May, 1980. Over 12,000

records were utilized. The information was originally available categorized into 16 different waste types. The University of California team undertaking the study broke these out into the 106 categories which has now become "The UCD Waste Category System".

The data from the two-month survey were multiplied by 6 to give a yearly figure for waste generation. A small adjustment was made to add pesticide containers disposed only during a four-month period not incorporating either of the survey months. The breakdowns of results of the study, both by UCD category and by SIC generators, are given in Tables D.6 and D.7.

D.14.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

Since this was a report on California waste, no reference is made by the report to Ontario. Including only the wastes judged to be of concern to OWMC, a total of 925,000 tonnes/year are estimated to be disposed in secure landfills in California in 1979/80. With a population of 24,000,000, this would be equivalent, by population ratio, to an Ontario total of 308,000 tonnes per year, or a per capita generation rate of 38.5 kg per year.

D.14.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

This report is of very limited usefulness to future waste quantities estimates for OWMC. It, like the OWMC European Tour Report (Section D.4), strengthens the view that the total waste quantity requiring off-site treatment in Ontario lies between 250 and 350,000 tonnes per year. While California is industrialized to a similar degree to Ontario, the mixtures of industries which contribute to the overall generation of waste is quite different. For example, in Ontario, Primary Metals are likely to be a much

larger contributor than Oil and Gas Extraction. For California, the reverse is true.

D.14.7 COMMENTARY

This approach is very similar to analyzing the MOE Waybill data, except California included many wastes, particularly solid wastes, not tracked by Ontario. The report would appear to be more limited than it, in fact, is, if one considers that it refers only to wastes deposited in secure landfill sites. The report points out, however, that alternative technologies to land disposal, viz. Physical/Chemical Biological Treatment and Incineration, "have not been widely used in California. At least four to six facilities will have to be licensed, financed, sited and built to safely handle our high priority wastes" [California: 1981, p 6]. Thus, the report, in fact, does assess the majority of wastes in California requiring off-site treatment and disposal.

TABLE D.6 - Summary of Hazardous Waste Quantities Disposed of in Class I and Class II-I Facilities by UCD Waste Category

[Source: California, 1981]

UCD #	WASTE CATEGORY	TONS/YEAR[1]	% STATE TOTAL
111	ACIDIC SOLUTION WITH HEAVY METALS	74,298	5.46
112	ACIDIC SOLUTION WITH OTHER METALS & NON-METALS	10,530	0.78
113	OTHER ACIDIC SOLUTION	24,720	1.82
121	ALKALINE SOLUTION WITH HEAVY METALS	17,790	1.31
122	ALKALINE SOLUTION WITH OTHER METALS & NON-METALS	38,562	2.84
123	OTHER ALKALINE SOLUTION	23,184	1.71
131	SPENT ETCHING/PLATING SOLUTION, ACIDIC	5,832	0.43
132	SPENT ETCHING/PLATING SOLUTION, ALKALINE	5,268	0.39
133	SPENT PICKLE LIQUOR	2,256	0.17
141	AQUEOUS SOLUTION WITH HEAVY METALS	24,120	1.78
142	AQUEOUS SOLUTION WITH OTHER METALS	22,116	1.63
143	AQUEOUS SOLUTION WITH REACTIVE ANIONS (includes cyanides - 17%, fluorides - 42%, sulfides - 16%, bromates - 20%, hypochlorites - 5%)	59,790	4.39
*144	OTHER AQUEOUS SOLUTIONS	4,596	0.34
145	BRINE	35,892	2.64
151	INORGANIC SOLIDS	1,512	0.11
153	INORGANIC (SOLID) CHEMICALS	540	0.04
*161	ASBESTOS AND WASTES	33,576	2.46
*162	ALUMINUM OR TIN DROSS	12	0.00
165	SPENT CATALYSTS	16,332	1.20
167	OTHER UNIDENTIFIED INORGANIC WASTES	1,542	0.11
211	HALOGENATED SOLVENT WITH HEAVY METALS	450	0.03
212	HALOGENATED SOLVENT WITH OTHER METALS	72	0.01
213	HALOGENATED SOLVENTS	6,924	0.51
214	NON-HALOGENATED SOLVENT WITH HEAVY METALS	1,524	0.11
215	NON-HALOGENATED SOLVENT WITH OTHER METALS	1,236	0.09
216	NON-HALOGENATED SOLVENTS	9,558	0.70
217	UNSPECIFIED SOLVENTS	3,342	0.25
221	ORGANIC LIQUID WITH HALOGENS & METALS (ALL KINDS)	2,598	0.19
222	ORGANIC LIQUID WITH HALOGENS ONLY	2,658	0.20
223	ORGANIC LIQUID WITH HEAVY METALS ONLY	1,362	0.10
224	OTHER ORGANIC LIQUIDS	3,480	0.26
225	AQUEOUS SOLUTION WITH ORGANIC RESIDUES, LESS THAN 10%	93,666	6.88
227	AQUEOUS SOLUTION WITH ORGANIC RESIDUES, GREATER THAN 10%	14,976	1.10
*231	ORGANIC SOLID WITH HALOGENS	120	0.01
*232	ORGANIC SOLID WITHOUT HALOGENS	576	0.04
241	PESTICIDES AND WASTES	69,480	5.10
242	PCB & MATERIAL CONTAINING PCB	1,374	0.10
243	PHARMACEUTICALS & WASTES	36	0.00
244	PHOTOCHEMICALS & WASTES	1,470	0.11
245	OFF-SPECIFICATION OR AGED ORGANICS	78	0.01
248	NON-HALOGENATED STILL BOTTOMS	486	0.04
251	TANNERY WASTES	11,100	0.82
*253	DETERGENTS & SOAP	2,130	0.16
254	ADHESIVES AND GLUE	594	0.04

[1]Estimated by extrapolating UCD data for 2 months and adding estimates for Big Blue Hills

TABLE D.6 (Contd)

UCD #	WASTE CATEGORY	TONS/YEAR	% STATE TOTAL
* 235	OTHER UNSPECIFIED ORGANIC WASTES	180	0.01
261	POLYMERIC RESIN WASTES	4,038	0.30
262	LATEX & WASTES	1,938	0.14
263	OTHER POLYMERIC MATERIAL WASTES	9,618	0.71
* 271	SEWAGE SLUDGE	984	0.07
* 272	OTHER BIOLOGICAL WASTES	1,494	0.11
281	WASTE OIL & MIXED OIL	7,602	0.56
282	OILY TANK BOTTOMS	3,984	0.29
283	MIXTURES OF OIL, SEDIMENTS & WATER	47,487	3.48
284	ACIDIC OILY SLUDGE	3,240	0.24
285	ALKALINE OILY SLUDGE	11,346	0.84
286	API SEPARATOR SLUDGE.	11,526	0.85
287	OILY SLUDGE	24,300	1.79
288	OILY SLUDGE WITH HEAVY METALS	4,770	0.35
289	MIXTURES OF OIL, GAS, WITH WATER	28,902	2.12
* 412	FILTER PRESS CAKE/SLUDGE	864	0.06
* 413	SCRUBBER SLUDGE	780	0.06
416	INK SLUDGE	1,152	0.08
417	ALUM & GYPSUM SLUDGE	156	0.01
431	HEAVY-METAL SLUDGE	64,512	4.74
433	OTHER METALS SLUDGE	19,194	1.41
441	LIME SLUDGE	21,738	1.60
* 442	PHOSPHATE SLUDGE	114	0.01
443	SULPHUR SLUDGE	32,706	2.41
445	PLATING/METAL FINISHING SLUDGE	6,276	0.46
446	DEGREASING SLUDGE	132	0.01
447	TETRAETHYL LEAD SLUDGE	18,822	1.38
* 453	PAPER PULP/SLUDGE	4,020	0.30
454	PAINT SLUDGE	36,810	2.71
455	DYE SLUDGE	54	0.00
* 456	OTHER WASTE TREATMENT SLUDGE	2,784	0.21
* 457	SLUDGES WITH ORGANIC RESIDUES	7,608	0.56
509	GAS CYLINDERS OR CONTAINERS	18	0.00
* 510	FLUE-GAS SCRUBBER LIQUID	78,474	5.77
* 511	RINSE WATER & WASTEWATER	24,012	1.77
512	SPILL CLEAN UP	366	0.03
513	LABORATORY WASTE CHEMICALS	2,676	0.20
* 514	CONTAMINATED SOIL & SAND	21,594	1.62
* 515	DRILLING MUD	130,782	9.61
518	DUST COLLECTOR WASTE	174	0.01
* 519	FLY ASH, RETORT ASH	2,634	0.19
521	SPENT CARTRIDGE FILTERS	60	0.00
523	TANK BOTTOM SEDIMENTS	54,690	4.01
* 524	CHEMICAL TOILET WASTE	960	0.07
* 525	METAL DUST & MACHINING WASTE	936	0.07
* 526	CANNERY WASTE	732	0.05
* 527	MUD/SEDIMENT & WATER	19,890	1.46
531	CONTAMINATED RAGS, PALLETS	1,266	0.09
532	CONTAMINATED EQUIPMENT CONTAINERS	6,736	0.50
* 535	TOTALLY UNSPECIFIED WASTES	2,994	0.22
	TOTAL	1,359,883	100.00%

*Wastes considered outside OWMC Mandate by OWMC Waste Quantities Study

TABLE D.7 - Generators of Hazardous Wastes by SIC Code

[Source: California, 1981]

CODE	INDUSTRY	TONS/YEAR[1]	% STATE TOTAL
07	AGRICULTURAL SERVICES	5,818	0.43
13	OIL & GAS EXTRACTION	265,164	19.52
20	FOOD & KINDRED PRODUCTS	4,890	0.07
24	LUMBER & WOOD PRODUCTS	990	0.07
26	PAPER & ALLIED PRODUCTS	10,242	0.75
2631	Paperboard Mills	6,600	0.49
27	PRINTING & PUBLISHING	1,824	0.13
28	CHEMICALS & ALLIED PRODUCTS	265,848	19.55
2816	Inorganic Pigments	15,072	1.11
2819	Industrial Inorganic Chemicals*	47,880	3.52
2821	Plastic Materials & Resins	29,166	2.15
2815	Paints & Allied Products	16,758	1.23
2869	Industrial Organic Chemicals*	26,436	1.95
2879	Agricultural Chemicals*	72,342	5.32
2899	Chemical Preparations*	26,760	1.97
29	PETROLEUM & COAL PRODUCTS	381,042	28.04
2911	Petroleum Refining	373,392	27.48
2952	Asphalt Felts & Coatings	4,482	0.33
30	RUBBER & MISC. PLASTIC PRODUCTS	1,146	0.08
31	LEATHER TANNING & FINISHING	11,694	0.86
32	STONE, CLAY & GLASS PRODUCTS	21,750	1.60
3275	Concrete Products	1,950	0.14
3292	Asbestos Products	14,352	1.06
33	PRIMARY METAL INDUSTRIES	26,802	1.97
3312	Blast Furnace & Steel Mills	13,674	1.01
34	FABRICATED METAL PRODUCTS	64,266	4.73
341	Metal Cans & Shipping Containers	8,382	0.62
347	Metal Services	30,540	2.25
3432	Plumbing Fittings & Brass Goods	10,572	0.78
35	MACHINERY, EXCEPT ELECTRICAL	18,360	1.35
3573	Electronic Computing Equipment	9,468	0.70

[1]Estimated by extrapolating UCD data for 2 months

*Not elsewhere classified in that 2-digit code

TABLE D.7 (Contd)

CODE	INDUSTRY	TONS/YEAR[1]	% STATE TOTAL
36	ELECTRIC & ELECTRONIC EQUIPMENT	55,300	4.08
3662	Radio & TV Communication Equipment	3,750	0.28
3674	Semiconductors & Related Devices	11,970	0.88
3679	Electronic Components*	29,082	2.14
37	TRANSPORTATION EQUIPMENT	47,392	3.50
371	Motor Vehicles & Equipment	19,250	1.42
372	Aircraft & Parts	16,782	1.24
376	Guided Missiles/Space Vehicle	10,272	0.76
38	INSTRUMENTS & RELATED PRODUCTS	7,740	0.57
382	Measuring & Control Devices	4,428	0.33
40	RAILROAD TRANSPORTATION	3,468	0.26
42	TRUCKING & SANITARY SERVICES	12,294	0.90
44	WATER TRANSPORTATION	1,578	0.12
45	AIR TRANSPORTATION	3,732	0.27
46	PIPELINES, EXCEPT NATURAL GAS	3,750	0.28
49	ELECTRIC, GAS & SANITARY SERVICES	69,270	5.10
493	Combination Utility Services	67,836	4.99
51	WHOLESALE TRADE-NONDURABLE GOODS	2,172	0.16
73	BUSINESS SERVICES	4,956	0.36
739	Miscellaneous business services	4,950	0.36
75	AUTO REPAIR SERVICES & GARAGES	1,842	0.14
96	DEPARTMENT OF FOOD & AGRICULTURE	1,962	.14
ADDITIONAL GENERATORS:			
100-1999	Other Minor SIC Groups	1,200	0.09
2000-3999	Other Minor SIC Groups	894	0.07
4000-9700	Other Minor SIC Groups	5,670	0.42
	Producers with Unidentifiable SIC Groups	29,796	2.19
	U.S. Naval Bases & Operations	19,764	1.45
	Industrial Waste Removal Services	9,546	0.70

[1]Estimated by extrapolating UCD data for 2 months

*Not elsewhere classified in that code

D.15 GCA CORPORATION - INDUSTRIAL WASTE SURVEY FOR THE STATE OF ILLINOIS

[GCA, 1980]

D.15.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

The Illinois industrial waste survey was one of several sources of input for the waste generation model employed in the OWMC Waste Quantities Study [OWMC, 1982 (a)].

The overall objective of the study was to provide essential inputs to a State-wide industrial waste management plan. These inputs included the relationship between industrial categories and their waste quantities, geographical distribution, generic composition, storage method and time, disposal method and disposal location.

A series of reports was prepared by the GCA Corporation for the State of Illinois. Together, they represent a comprehensive assessment of industrial waste management in the State, addressing such issues as the current fate of wastes, recycle and recovery, and waste management alternatives.

D.15.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

The Illinois Environmental Protection Agency conducted a survey of industrial wastes produced in that State. The survey "did not distinguish between hazardous and non-hazardous wastes". The survey results were summarized to produce estimates of process wastes. These wastes included oils and solvents, metal containing liquids, sludges, dusts, and process solids, but excluded effluents discharged to sewers or surface waters and trash such as paper, wood and scrap metal.

Results of the survey were augmented by a review of approximately 2,500 Illinois Special Wastes Supplemental Permits. The permits represented wastes which, "because of their properties or other factors" were landfilled, and did not include wastes which were treated or disposed of by other means.

D.15.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

The Illinois survey employed 27 waste types in its questionnaire. The standard industrial classification (SIC) for surveyed industries were also recorded and resulted in 1751 SIC-waste type combinations. Summary sheets were prepared which grouped the SIC-waste type combinations into 252 sub-categories of waste types. For example, waste type 1 (waste oils) included 23 sub-categories including type 1-1 (waste oil - foods), which was found to be applicable to SICs 2023 and 2026.

Results of the survey, waste permits and literature were used to detail key components and trace contaminants in each sub-category of waste.

D.15.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

A survey questionnaire was mailed to 20,981 companies in Illinois. A total of 7,846 companies responded representing 37% of the facilities or 61% of the industrial employees. Waste permits and literature sources were used to further qualify the wastes reported in the survey.

D.15.5 HOW DID THE STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

This survey was unrelated to Ontario. However, the methodology of extrapolation used by the study to project state-wide Illinois data is discussed briefly below.

Results of the Illinois industrial waste survey were projected (from those who did not respond) to the entire survey (respondents plus non-respondents). The state-wide totals were extrapolated from values reported for each four-digit SIC code, on the basis of either the number of industries or the number of employees in the industries surveyed versus the total in the SIC group. This method assumed that "the reported data for an SIC represents a good cross-section of the SIC".

Projections were also made to obtain estimates of waste generation on county basis. In this case, the wastes projected for each SIC on a State-wide basis were allocated to each county according to the fraction of Illinois industries or employees in those industries which were located in that county.

D.15.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

The Illinois industrial waste survey provides a data base relating waste generation to SIC code founded on a large number of questionnaires. It also details (through waste hauling permits) the likely composition of many of the waste streams reported.

Two crucial factors impact upon the applicability of the Illinois data to Ontario, viz. the survey did not explicitly differentiate between hazardous and non-hazardous wastes and ash generated from the widespread use of coal for power generation in the State significantly influenced the waste quantities reported.

D.15.7 COMMENTARY

The authors of the Illinois report made a number of interesting observations, based on their review of waste generation data. Some of these are summarized in point form below:

- many wastes defied classification because of their process and materials specific nature
- within single (four-digit) SIC codes, the waste descriptions varied greatly
- the wastes reported by a facility may result from a secondary SIC code activity which is not related to its primary SIC code
- coal mine "refuse" from SIC 1211 was projected from survey results to account for 40% of the projected total industrial process wastes generated in the State.

D.16 NEW YORK DEPARTMENT OF ENVIRONMENTAL CONSERVATION INDUSTRIAL HAZARDOUS WASTE GENERATION IN NEW YORK STATE AN INVENTORY

[Ianotti et al, 1979]

D.16.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

The New York hazardous waste inventory was one of several sources of information on hazardous waste generation rates employed in the OWMC Waste Quantities Study [OWMC, 1982]. The New York study was also a key reference for the Northern and Western Canada study conducted by Reid, Crowther and Partners Limited [Reid Crowther, 1980]. This Northern and Western Canada study was also a source of waste generation data for the OWMC Waste Quantities Study.

The objective ot the New York inventory was to determine the magnitude of the problem of hazardous waste in the State, and to develop an adequate data base for an effective and workable hazardous waste management plan.

D.16.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

The New York State inventory was intended to determine the amounts, types, composition and disposition of "special" industrial wastes where "special" wastes are defined as those "which, because they present a hazard to the environment or human health, require special handling". These wastes included solids, sludges, slurries, liquids and contained gases and were primarily those which were either land disposed at the facility or transported elsewhere for treatment or disposal.

The New York State Department of Environmental Conservation (DEC) employed criteria for defining wastes for the study which were the same, with few exceptions, as those in Section 3001 of Subtitle C of RCRA (in its

draft form in 1979). Under these criteria, wastes such as flyash, slag, foundry sand, brine solutions, some inorganic alkaline wastewaters and contaminated packing from raw materials were not included in the inventory as being hazardous wastes.

D.16.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

The New York hazardous waste inventory questionnaire used a detailed waste type listing (125 types) augmented by a listing of 500 waste components. Individual waste streams were also characterized according to their hazardous properties (flamable, toxic, reactive, explosive, corrosive).

D.16.4 WHAT METHOD DID THIS STUDY USE TO GENERATE WASTE QUANTITY DATA?

The New York State hazardous waste inventory sought to identify and survey industries most likely to generate significant quantities of hazardous waste. Selection of industries was based primarily on the results of U.S. EPA contract studies, which determined that the industries most likely to generate hazardous wastes included inorganic and organic chemicals, petroleum refining, pharmaceuticals, pesticides and explosives, primary metals, leather tanning and finishing, batteries, electroplating and metal finishing, paint and allied products, textile finishing and dying, rubber and plastics, metals mining, machine manufacturing and waste oil rerefining. In addition, in New York, photographic chemicals, electronic components and aircraft and motor vehicle manufacturing were known to be significant sources.

The technique of selection of industries to be inventoried varied according to the nature of particular categories. In machinery manufacturing, waste generation was assumed to be proportional to the number of employees, and, hence, large industries were selected. Some industrial categories, suspected of having a particularly high potential for hazardous

waste production, e.g. chemicals and primary metals, were considered to warrant surveying regardless of their size. Other industrial categories which included a large proportion of facilities not involved in primary production, e.g. the pharmaceutical industry, were reviewed so as to exclude fabricators from the survey. Another factor used in the selection of significant waste generators was access to municipal sewer. This was on the basis that some companies, e.g. electroplaters, were usually permitted to discharge to sewers, and, hence, preference was given to those industries not attached to municipal systems.

Waste generation was determined for 1170 industrial plants, representing 98% of questionnaires mailed to selected companies.

D.16.5 HOW DID THIS STUDY EXTRAPOLATE WASTE QUANTITIES TO ONTARIO DATA?

This report was not directly concerned with Ontario wastes. Methods used to extrapolate data in New York are discussed below.

The approximately 1.0 million tonnes of hazardous waste determined from inventory questionnaire was assumed to represent essentially all (over 90%) of the hazardous wastes generated in the State. This was based on the observation that the largest companies, representing approximately 10% of companies surveyed, were responsible for over 90% of the hazardous waste obtained from the inventory. The remainder of the wastes were generated by small to medium sized firms that produced significant quantities of waste. The remaining firms in the State were presumed to generate small quantities of waste, which were mainly solvents, oils and heavy metal sludges.

Using a simple population ratio between Ontario and New York would suggest a generation rate of about 505,000 tonnes for Ontario, of which about 225,000 tonnes would require off-site treatment facilities.

D.16.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

While this report is of little direct relevance to estimates of Ontario waste quantities, its interestingly biased approach to waste surveying is a method which should be considered for future waste quantity estimates.

The New York inventory is one of fairly few hazardous waste surveys which endeavoured to measure directly the total quantity of wastes produced in a jurisdiction. The results provided a very detailed assessment of both hazardous waste generation and management in this neighbouring State.

D.16.7 COMMENTARY

The New York inventory employed SIC codes to characterize the relative contributions of industrial sectors. The inventory did not, however, employ waste generation factors, neither on an employee or a plant-wise basis, although this information is provided in their report. Generation factors developed from SIC and waste quantities reported by the inventory would reflect the highly biased procedure used to select candidate industries for the survey.

D.17 BARR ENGINEERING CO. ET AL - HAZARDOUS WASTE MANAGEMENT - MINNESOTA'S ISSUES/OPTIONS

D.17.1 WHAT IS THE RELEVANCE OF THIS STUDY TO OWMC?

The Minnesota hazardous waste study was reported to have been one of several sources of hazardous waste generation rates employed in the OWMC Waste Quantities Study (Section D.2). The Minnesota study had several objectives, including the quantification of that State's hazardous waste stream.

D.17.2 WHAT WASTE QUANTITY IS THIS STUDY ESTIMATING?

The Minnesota study preceded the development of a comprehensive definition of hazardous waste. For this study, hazardous waste was broadly defined as "industrial waste that was not allowed to be deposited in sanitary landfills". Also excluded were such large volume wastes as fly and bottoms ash, gas scrubber sludge, taconite mining waste and sludges from pulp and paper manufacturing. These wastes were considered to be adequately managed on the property of the waste generators, under existing permits of the Minnesota Pollution Control Agency. Some wastes included in the survey were thought, by the report's authors, to "likely turn out to be non-hazardous under the eventual State definition of hazardous waste". For that reason, wastes identified in the report were described as "potentially hazardous".

D.17.3 WHAT WASTE CATEGORIES DOES THIS STUDY USE?

The Minnesota study reported hazardous wastes in ten categories. Wastes were placed in these categories or groups on the basis of similarity of technical management options. The specific criteria employed were:

"(1) Presence of organic material because of the feasibility of incinerating such materials

(2) Presence of halogenated hydrocarbons because of the need for special air pollution control equipment on incinerators treating these wastes and because of the environmental persistence of many of these wastes

(3) Presence of oil and solvents because of the availability of technology and facilities to recover beneficial products from these wastes

(4) Presence of cyanide because of special processing needs and the need to oxidize this constituent prior to containment

(5) Presence of heavy metals because of their toxicity and the need to remove these materials prior to containment

(6) Presence of acids or alkalines because of special handling and processing problems and the need for neutralization prior to containment".

D.17.4 WHAT METHOD DID THE STUDY USE TO GENERATE WASTE QUANTITY DATA?

Several data sources were referred to in the Minnesota study to obtain information on hazardous waste generation in the State. The primary source employed was a report entitled "Chemical Waste Characterization Report for the Chemical Waste Land Disposal Facility Plan" which was completed for the Metropolitan Waste Control Commission in January, 1977. That study employed results of a survey of industries in the Twin Cities area of Minnesota. Data from that study were recognized to have some shortcomings. Notably it included manufacturing industries only; it covered a limited geographical area, and it was skewed towards industries using the Metropolitan sewer system. These shortcomings were ameliorated by employing the results of other (more limited) waste surveys conducted in Minnesota.

D.17.5 HOW DID THE STUDY EXTRAPOLATE WASTE QUANTITY ESTIMATES TO ONTARIO DATA?

Waste estimated for the Twin Cities Metropolitan Area was extrapolated to the 80 county out-state area of Minnesota. The method employed to perform this entailed the categorization of waste generating industries in to two-digit SIC groups and extrapolating by the number of employees in the out-state area and the sample group.

It was recognized that extrapolating by two-digit SIC groups tended to "skew" the results for waste generation in some cases. This skewing occured when a high rate of waste generation was reported by a particular four-digit SIC group. An example presented was the brewery industry (SIC 2082) which produced a large amount of caustic waste per employee in relation to other industries in the Food and Kindred Products group (SIC 20). The extrapolation procedure used in the study was adjusted to take account for this skewing effect.

D.17.6 HOW USEFUL IS THIS REPORT TO FUTURE WASTE QUANTITY ESTIMATES?

The Minnesota study is of little value to OWMC directly. Its estimate was, in its own terms, "limited by the scope of the study to reviewing, interpreting and comparing various sources of hazardous waste data".

The study does make some useful observations on the precautions required when extrapolating on the basis of two-digit SICs.

D.17.7 COMMENTARY

This study is now quite dated. Also, little background information on waste generation was presented.